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SCIENTIFIC AND TECHNICAL PRESENTATIONS TO THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE AT ITS THIRTY-FIRST SESSION

Report by the Secretariat

1. During the thirty-first session of the Scientific and Technical Subcommittee, the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) and the International Astronautical Federation (IAF), in liaison with Member States, organized a symposium on the theme "Space applications for disaster prevention, warning, mitigation and relief". The symposium was organized in accordance with the recommendation of the Subcommittee at its thirtieth session (A/AC.105/543, paras. 110-111), which was subsequently endorsed by the Committee on the Peaceful Uses of Outer Space at its thirty-sixth session 1/ and by the General Assembly in its resolution 48/39 of 10 December 1993.

2. The symposium was the tenth to be organized by COSPAR and IAF during the annual sessions of the Scientific and Technical Subcommittee, the topic for each season being selected by the Subcommittee at its previous session. The symposium was held on 21 and 22 February 1994, following the completion of the debate in the afternoon meetings of the Subcommittee.

3. In addition to the special presentations organized by COSPAR and IAF at the request of the Subcommittee, Member States organized a number of scientific and technical presentations, which were made by specialists in space science and applications, relating to various items on the agenda of the Subcommittee. Several international and national organizations also made special presentations on their scientific and technical activities.

4. In order to make more widely available the information on recent developments in space science, technology and applications presented during the symposium and the other presentations, the Secretariat has prepared a summary of that information, which is presented below.

5. The annex contains a more detailed description of the scientific and technical presentations made before the Scientific and Technical Subcommittee at its thirty-first session. Because of the technical character of the material, the annex is in English only. A list of the presentations and the speakers is contained in the appendix to the annex.

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*Reissued for technical reasons.

SUMMARY OF PRESENTATIONS

6. After 35 years of space research, observation of the Earth by satellites is widely used in applications for disaster warning and prevention. Many different types of natural disasters or other catastrophic events frequently occur as a result of natural phenomena or human activities. These events may require short-term observations, as is the case for observing floods, forest fires, typhoons and earthquakes, or long-term monitoring, as is the case for desertification, deforestation, global warming and sea-level rise.

7. Observation of the Earth from satellites, with their ability to provide continuous monitoring and global, repetitive coverage, offers a number of advantages compared with other techniques. Digital data sets generated via satellite observations also facilitate the observation of rural and remote areas with difficult terrain and provide consistent data sets, which are important for thorough analyses.

8. The introduction of new technologies is sustaining and improving the effectiveness of satellite systems, but there is still no operational satellite system dedicated specifically to disaster monitoring. The European Space Agency (ESA), together with China, India, Japan and the United States of America, is playing a major role in deploying Earth observation satellites to be used for disaster warning and environmental monitoring.

9. ESA systems dedicated to disaster warning and environmental monitoring include the geostationary meteorological satellites of the Meteosat series and the polar-orbiting European Remote Sensing satellite (ERS) series. The utility of ERS-1 data for monitoring disasters or catastrophic events has already been demonstrated on various occasions and will be increased in fields such as atmospheric chemistry and the monitoring of land surface processes with the launch of ERS-2. The SPOT series of satellites, operated by a private company, provides high resolution optical images of the Earth's surface and the joint French/United States Topex/Poseidon satellite systems allow continuous monitoring of ocean topography.

10. Because of recent technological developments and ongoing research, many geophysicists now envisage the day when they will be able to predict natural disasters with some degree of accuracy. An encouraging indication of such progress is the proliferation of observations of signals and events that are associated with earthquakes and volcanic eruptions.

11. Space technology plays an important role in seismic risk mapping, which, particularly in intra-continental areas, requires mapping of all known faults, as earthquakes always occur on pre-existing faults. Since their respective launches, the SPOT and Landsat remote-sensing satellites have proved to be remarkably well equipped with fault-mapping tools. In some circumstances high-resolution space imaging can even be used to measure the cumulative displacement of the more active faults and can thus deduce displacement rates.

12. New techniques using synthetic aperture radar data are undergoing development and the images produced by ERS-1 satellites are ideal for predicting volcanic eruptions. The techniques make it possible not only to measure movements of the ground, but also to identify exactly the topography of the volcanic formations and the direction and ruggedness of the slopes. Those are crucial factors in anticipating the location and extent of lava flows.

13. In a few specific active zones, such as California, United States, these deformations are regularly measured within distances ranging from one kilometre to several hundred kilometres, in order to distinguish local influences associated with the seismic cycle. It is only by using spatial techniques that these measurements can be made over such a range of distances. For the longest-range measurements, satellite laser telemetry and interferometry techniques are used. At the local level, the preferred method is the application of Global Positioning System (GPS) satellites, which are now accurate to within a centimetre and can produce a detailed description of a deformation in the vicinity of a fault.

14. In the past decade the National Oceanic and Atmospheric Administration (NOAA) of the United States has established a temperature and moisture sounding capability in its new polar and geostationary satellite programmes. Data from these systems supplement the visible and infrared imagery available from other satellite systems. Applications of these technologies include temperature and moisture analyses for weather prediction, analysis of weather stability, estimation of tropical cyclone intensity and position, and global analysis of clouds.

15. Having accurate wind measurements is a prerequisite for predicting hurricanes. In a recent study of the past six hurricane seasons in the United States, NOAA satellites derived wind analyses, which produced a reduction of 10 per cent in the mean forecast error in hurricane track prediction and contributed significantly to early monitoring of such catastrophic events. Microwave observations from the current NOAA polar-orbiting satellites are also used to locate tropical cyclones and to estimate their surface intensity. By penetrating the cloud cover associated with tropical cyclones, it is possible to capture the characteristic upper-level warm temperature anomaly. This information is also valuable for predicting storms and the meteorological community is increasingly using it to supplement reconnaissance flight and other conventional data.

16. Desertification is defined as land degradation in arid, semi-arid and dry subhumid areas. It is caused by adverse human activities and climatic changes. The processes involved include wind and water erosion, salinization, waterlogging and chemical pollution. According to a desertification assessment made in 1991, 25 per cent of the Earth's surface is affected by desertification.

17. In China, where desertification is a serious problem and is the focus of a concerted containment effort, a map of erosion types and erosion intensity has been compiled by using the Landsat Thematic Mapper, multi spectral scanners and tunable laser spectrometers to make false colour composite satellite images and colour infrared aerial photos. In addition, another map was developed by combining geographical analysis with remote-sensing techniques, interpretation and land survey, which made it possible to evaluate erosion intensity. The use of such maps, created with the help of space technology, can lead to a better understanding of short- and long-term processes of erosion and desertification and can contribute to enhanced measures against these problems.

18. The experience in India has shown that the combination of telecommunications and meteorological satellites can be of great importance in predicting catastrophic events. While the capabilities of communication satellites in disaster warning, data transfer, and relief operations have been furthered by the advent of very small aperture terminals and ultra small aperture terminals, meteorological satellites are providing vital information on such variables as clouds, temperature, humidity and wind characteristics. These derived imageries are particularly useful in identifying cloud systems over the ocean, for tracking, assessing the intensity of and predicting storm surges and cyclones. One of their most notable uses occurred before a cyclone hit the coast of Andhra Pradesh in India in 1990. Over 170,000 people could be evacuated on time; thus, thousands of lives in that area were saved.

19. In Bangladesh, a nationwide flood forecasting and warning service has been developed by integrating satellite-derived cloud pattern data and field data. Significant achievements have also been made by China in satellite-based precipitation forecasting and flood management. In Nepal, NOAA images are used for flood warning in the entire region. The successful launching of the second generation of satellites of the Indian National Satellite System (INSAT) has greatly improved space technology applications in the fields of weather monitoring and disaster warning throughout the region.

20. A remote sensing-based National Agricultural Drought Assessment and Monitoring System for country-wide monitoring in India has been developed and is being used for operational monitoring. In the first phase, the System integrates rainfall and aridity anomalies with other data sets in order to provide realistic

assessment of droughts. Drought bulletins for drought-prone districts of the country are issued to relevant user agencies at all levels so they may take action if necessary. Based on user feedback, the second phase of the National Agricultural Drought Assessment and Monitoring System was launched in 1992. This phase includes detailed monthly drought assessment in terms of spatial variability and impact on crop and fodder production.

21. In 1975, as part of the follow-up to the World Food Conference, held at Rome from 5 to 16 November 1974, the Food and Agriculture Organization of the United Nations (FAO) established the Global Information and Early Warning System on Food and Agriculture. The primary purpose of the System is to monitor food supplies and demand conditions on a global scale, to identify countries or regions where food shortages are imminent and to assess possible emergency food requirements.

22. Since 1976, FAO has actively been developing and testing the use of data from environmental and Earth resource satellites for improving the databases of the Global Information and Early Warning System on Food and Agriculture and the Desert Locust Plague Prevention Programme at the international, regional and national levels. Starting in 1977, Meteosat imagery has been analysed visually for the monitoring of rainfall over Africa.

23. In 1985, a project was initiated to develop and implement a highly automated system for the acquisition, production and distribution of satellite data. The system, Africa Real Time Environmental Monitoring using Imaging Satellites (ARTEMIS), became operational in August 1988 and is still in service. ARTEMIS relies on two data sources: the NOAA series of satellites and Meteosat. The operational production at present covers Africa and the Near East and archived data go back to 1981. The data are continuously updated and are becoming more and more valuable, not only for early warning purposes, but also for more general environmental studies.

24. All the data produced by ARTEMIS are disseminated directly to a large number of users, both at FAO headquarters and in Africa. The users at FAO headquarters include the Global Information and Early Warning System on Food and Agriculture and the Desert Locust Plague Prevention Programme. The users within Africa, which include all national and regional early warning systems, depend mainly on pouch or courier services for data delivery, which can cause delays. Transmission of the data to certain locations in Africa, however, is now taking place via electronic mail facilities and the Direct Information Access Network for Africa (DIANA) system.

25. DIANA was developed by ESA in collaboration with FAO and currently is comprised of an uplink station in Italy and three microcomputer-based receiving stations, in Ghana, Kenya and Zimbabwe. Using these electronic communication channels, African users of ARTEMIS information are able to receive digital data without any delay.

26. In the future, ARTEMIS will increasingly be focusing on the provision of expertise and coordination in the fields of training, calibration and further development of application modules and low-cost systems, in addition to providing, by continuing the operational production of its routine maps, a backup to local production facilities. Furthermore, the development of regional programmes for environmental monitoring using remote-sensing satellites, thereby putting the early warning application in a wider context of environmental management, will be of great importance.

27. As a result of the increasing global population and population densities, the impact of natural disasters on humanity is becoming more and more severe. Although present space-based, air-based, and ground-based technologies make it possible to mitigate the effect of disasters, no worldwide disaster monitoring system has to date been put in place. Consequently, students of the International Space University have developed in a design study the Global Emergency Observation and Warning (GEOWARN) system, which could serve as

a worldwide institution for filling the current gaps of development in fields such as Earth observation, data processing, information dissemination, and telecommunication support for disaster warning and relief. The system, which would be open to all countries for humanitarian purposes, may be implemented over the next decade. The provision of detailed disaster information, the facilitation of emergency communications and the provision of interface personnel would be the main targets of the system. To that end, the GEOWARN system would strongly interact and cooperate with existing organizations such as FAO and the World Meteorological Organization (WMO).

28. Cooperation between new end-users and more traditional users is essential if the contribution that space can make is to be maximized. Space techniques can not only provide increasingly accurate and sophisticated measurements, but can also interrogate remotely situated sensors on the ground and transmit warnings and other large packets of information to multiple addresses. The real difficulties arise with the integration of different national and international ground infrastructures. The detection of an earthquake or the prediction of the track of a hurricane may be feasible, but it serves little practical purpose if the people affected are not warned immediately and either evacuated or given protection. The real application and benefits of these new techniques are dependent on integrating them into effective action on the ground.

29. On the question of the space environment, studies indicate that the evolution of the debris population is currently beyond human control. Only 22 per cent of all payloads currently in orbit are operational. Those functioning payloads represent only 5 per cent of the more than 7,000 objects tracked by United States military authorities. Redundant launch-vehicle upper stages represent an additional 16 per cent of the population, mission-related objects contribute a further 12 per cent, and fragments from breakups make up the remaining 45 per cent. Therefore, the behaviour of 95 per cent of the objects that can be tracked and all of the smaller size debris population cannot be controlled.

30. Research on space debris conducted in Germany is carried out either on a national basis or is funded under contracts with the ESA European Space Research and Technology Centre and the European Space Operations Centre (ESOC). The nationally funded research activities are largely concentrated in the Institute for Space Flight Technology and Nuclear Reactor Technology of the Technical University of Braunschweig and the Research Establishment for Applied Science (FGAN) under research contracts awarded by the German Space Agency (DARA) and ESA. Most of the work has been successfully performed in close cooperation with researchers from the National Aeronautics and Space Administration (NASA) of the United States.

31. Assessing the present and future risk to all space objects requires the use of models. The ESA meteoric and space debris terrestrial reference model has been developed by the Institute for Space Flight Technology and Nuclear Reactor Technology under an ESOC contract. The scope of the model covers human-made and natural objects larger than 0.1 mm in altitudes below 2,000 km. Analytical breakup models are used for the individual generation of the untracked debris population for the known on-orbit fragmentations (116 as of July 1993). The observable part of the debris population is monitored via ground-based radar measurements. For each generated population member, information is retained on its origin, mass, size and orbit. Flux information is resolved with respect to the source of impact, its mass, the impact velocity, the impact azimuth angle, the impact elevation angle and the position of the impact occurrence along the orbit of the target.

32. India has also developed theoretical models of debris generation caused by the disintegration of objects or by collision between objects. The models are designed to provide a better understanding of the untracked debris environment and predicting collision probability for operational spacecraft.

33. A joint research effort is being conducted by NASA and FGAN to characterize and compare debris shape, size, intrinsic motion, mass, and orbital lifetime of different types of breakups, for example from collisions and from explosions. At present, radar data on 30 debris objects (larger than 50 cm) are being

analysed. A statistical analysis of measured radar cross-section and a comparison with NASA results derived from effective areas of infrared, optical and radar measurements have also been started.

34. ESA has been actively addressing the space debris issue for several years. Its early concerns were the uncontrolled re-entry of spacecraft (e.g. the nuclear-powered Cosmos 954 and Skylab space station), collision risk in the geostationary orbit and ensuring the safety of manned spaceflight. The Council of ESA in 1989 defined the objectives of the Agency in the field of space debris and approved a plan of activities, which included as a main element a space debris programme. In 1990, the ESA space debris advisory group, composed of experts from ESA member States, was created to advise the Agency in all matters related to space debris. The purpose of the ESA space debris research programme is to reach a better understanding of critical issues and to carry out preparations for future programmes.

35. Europe has no system for space surveillance, that is, the systematic monitoring of all space objects. Some facilities exist, however, for the tracking of selected objects. They include the FGAN radar facility at Wachtberg, Germany. With a powerful 34-metre parabolic antenna, the radar, which operates in L-band and Ku-band, providing narrow-band as well as high-resolution radar data, space objects can be tracked over large areas of Europe. Research on the physical characteristics (radar cross-section, shape, mass, altitude) of space objects is carried out. Upon re-entry of risk objects, radar and optical stations in France also provide data for re-entry predictions. A survey on the use of ground- or space-based optical and infrared sensors for the detection and tracking of space debris has been carried out in the United Kingdom of Great Britain and Northern Ireland. Efforts are also being made to improve European ground-based observation capabilities with radar and optical sensors. Plans have been made to install a 1-metre Zeiss telescope on the Canary Islands of Spain as an optical ground site for a Silex experiment within the ARTEMIS project. After appropriate modifications and upgrades, the telescope can also be used for space debris observations, particularly for objects in geostationary and geostationary transfer orbits.

36. Research in the United Kingdom has shown that a quantitative assessment of detrimental impact will make it possible for environmental hazards of space debris to be characterized and for "acceptable" levels of degradation to be identified. The insurance industry will be keen to indirectly protect the future missions that they will underwrite by protecting the environment in which those assets will operate. Thus, a mission that would increase the hazard of collisions in orbit could be subject to penalty premiums, related to the detrimental impact of the mission. That would provide financial encouragement to operators to adopt appropriate debris mitigation practices in design and operations, or at least provide them with a cost trade-off between the two. The proposed quantitative approach therefore has two aims. The first is to encourage the adoption of debris mitigation principles in mission design by illustrating the cost benefits associated with such measures. The second is to maintain unlimited access to orbit for all responsible users who wish to continue to exploit the commercial, strategic and scientific potential of near-Earth space.

37. The United Kingdom has proposed a risk-based approach to the problem of possible collisions between space debris and satellites with nuclear power sources. Before an additional item of debris is created, it then becomes appropriate to evaluate the risk it poses over its lifetime to the whole population of orbiting items during that time and to compare the result with the cost of alternatives. Similarly, the risk from parking a satellite with a nuclear power source on board in a high orbit can be, in principle, evaluated taking account of existing debris. While this approach is technically demanding, it seems conceptually straightforward.

38. As space debris is a global problem that only can be solved by a joint effort, discussions and cooperation among space agencies and related organizations are of paramount importance. Regular coordination meetings have been held between ESA and NASA since 1987. In 1993, the Inter-Agency Space Debris Coordination Committee was created. Its members are ESA, entities from Japan, NASA and the Russian Space Agency. The primary purpose of the Committee is to exchange information on space debris research, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities

and to identify debris mitigation options. In particular, there is a recognized need to develop a common database of the space debris environment that will be supported by the surveillance networks and observation facilities of all the participants.

39. To mitigate the problem of space debris, space agencies have adopted some voluntary measures. For example, the National Centre for Space Studies (CNES) of France, together with Arianespace, instituted a policy of residual fuel venting from the upper stage of the Ariane launcher in case of launches into low altitude circular orbits (SPOT 2, ERS-1 and Topex/Poseidon) to prevent explosions. Since Ariane flight V59, fuel venting of the third stage has also been conducted as a routine procedure regardless of the type of the target orbit.

40. United States policy requires that space activities be carried out so as to minimize orbital debris. This policy requires each programme to conduct a formal assessment of its potential to generate orbital debris. A handbook to support implementation of the policy is being prepared by NASA to reduce the time and costs for performing such assessments and to assure that consistent standards and criteria are applied to all projects. This work is being sponsored by the office of safety and mission quality at NASA headquarters.

41. The problem of space debris is also being investigated by international organizations, such as IAF and the International Academy of Astronautics (IAA). IAA initiated a study to be performed by experts from its committee on safety, rescue and quality. The objectives are to evaluate the need for action and to indicate ways to reduce the hazards. The document containing the study was approved in October 1993 as an official IAA position paper.

42. India has its own satellite remote-sensing capability with complete space and ground infrastructure. Currently, two Indian remote-sensing satellites (IRS-1A and IRS-1B), equipped with linear imaging self-scanning sensors, provide data on the Indian subcontinent on a regular basis. The designed spectral resolution allows the identification of land cover vegetation with subtle spectral differences and enhanced mapping capabilities on large scales (i.e. 1:50,000). The new series of Indian remote-sensing satellites (IRS-1C/D) will form the second generation of the Indian remote-sensing system and will have improved features such as higher resolution, sensing capabilities in the middle infrared band, stereo viewing, repeated coverage of a particular area and on-board data processing.

43. India has used a variety of data from the NOAA Advanced Very High Resolution Radiometer (AVHRR) receiving station to conduct National Agricultural Drought Assessment and Monitoring System studies. The studies indicate a correlation of up to four weeks with rainfall and aridity anomaly. The forest cover maps generated by visual interpretation of Landsat and NOAA data show close similarity of closed forest, open/degraded forest and non-forest areas. A technique to evaluate potential vegetation cover using a multidate maximum vegetation index generated by the AVHRR receiving station of NOAA has also been developed in India. Such maps can be of immense value to studying vegetation, its phenology, biomass and productivity. The data could also be used in global climatic models for albedo, productivity as a function of carbon sink etc.

44. The Hubble Space Telescope is a collaborative project involving NASA and ESA. The telescope initially had a complement of five scientific instruments: two cameras, two spectrographs and one photometer. Light is collected by a mirror 2.4 metres in diameter. Within several weeks after launch, however, it became obvious that the mirror was polished to the wrong geometric shape, which resulted in images showing spherical aberration, that is, much less than the expected amount of energy was collected in the central peak of the images.

45. The Hubble Space Telescope was designed to be refurbished in orbit, as it was unlikely that all the components of the highly sophisticated space observatory would remain operational throughout the planned

15-year lifetime of the spacecraft. Thus, several of the malfunctions that occurred between 1990 and 1993 (most of which were temporarily corrected through the use of redundant components), had actually been anticipated. However, the main mirror could obviously not be exchanged in orbit. The solar panels, which caused serious operational problems because of thermally induced jitter, could be replaced in orbit, but replacement panels had to be manufactured. It was also fortunate that even before the launch of the Hubble Space Telescope, preparations had been made to replace the main camera on the telescope.

46. The astronauts that took part in the first Hubble Space Telescope servicing mission replaced failed gyroscopes and drive electronics, changed electrical fuses, replaced the solar arrays, installed a new wide field/planetary camera, installed new magnetometers, installed the corrective optics space telescope axial replacement, upgraded the on-board computer, installed new solar array drive electronics and installed a repair kit on the Goddard high-resolution spectrograph. The ambitious mission was executed with admirable success, after which the Hubble Space Telescope was boosted into a higher orbit.

47. It took several weeks for the Hubble Space Telescope to make the transition from operations prior to the instalment of the corrective optics space telescope axial replacement and those following its instalment. It was a carefully orchestrated undertaking designed to optimize the performance of all instruments. It was during that process that it became obvious that the servicing mission had been a tremendous success. Astronomers now have an excellent tool that is capable of answering many of the questions that modern astronomy poses.

48. Astronomers have been among the many beneficiaries of the dramatic scientific and technological progress that has been achieved worldwide since the 1950s, primarily through the development of more sensitive detectors, novel telescopes and the opportunity to not only observe from space, but also to fly by the other planets of the solar system. While bestowing powerful gifts upon the astronomical community, the technological age has also brought unprecedented levels of atmospheric noise to which radio astronomy is particularly vulnerable.

49. Despite the allocation of 2 per cent of all bandwidths for radioastronomy uses and the internationally binding nature of the relevant agreements of the International Telecommunication Union (ITU), there are daily violations of those reserved bands. Some violations arise from inadequate standards of electronic engineering that permit leakage or drift of transmitted power into the reserved band, or through the generation of harmonic frequencies that fall into a reserved band. Satellites of the Global Navigation Satellite System (GLONASS), which used spread frequency transmissions, made observation of the important astrophysical maser line at 1612 megahertz (MHz) almost impossible because they utilized that frequency as their central transmitting frequency. Fortunately, this unforeseen problem resulting from a shared band is now in the course of being resolved in favour of astronomers thanks to the good will of the GLONASS authorities. Astronomers will be looking forward to 1999, when the last unmodified GLONASS satellite will be phased out.

50. Space astronomy is also threatened, like every other activity in space, by the growing threat of space debris. The number of debris trails on deep sky astronomical plates has reached the point where one in three plates now carries one or more debris trails. Some plates are completely degraded for any scientific purpose by the sheer number of debris trails. A piece of debris crossing the field of view during photometric observations ruins the data and, if the trail is bright enough, may cause irreparable damage to sensitive detectors.

51. In recent years there have been a number of suggestions for the launch of large solar reflectors to mark particular events, for example the centenary of the Eiffel tower or the 1996 Olympic Games. To be seen on Earth, most of these proposals require the perceived brightness of the reflector to be that of the full Moon. Clearly, current proposals may not represent a significant threat to astronomy, but inevitable development

could lead to the abandonment of any ground-based astronomy because even small solar reflectors inadvertently reflecting a beam across an unsuspecting observatory could wreak havoc on sensitive instruments.

52. The astronomical community is using all the means at its disposal to inform responsible institutions about these threats posed to a science that has existed for millennia. Fortunately, there is support for astronomical science; for example, new outdoor lighting designs are available that can minimize upward light escape and the GLONASS transmission scheme is in the process of being redesigned. ITU still reserves frequency bands for radio astronomy; and the organizers of the 1996 Olympic Games at Atlanta, Georgia, in the United States have turned down a proposal to use a solar reflector as a means of advertising. In the absence of firm international agreements, however, too much depends on local bilateral agreements and on the efforts of a few dedicated people.

53. The first German Spacelab mission (D-1) was successfully completed in 1985. The second German Spacelab mission (D-2) was launched on 26 April 1993 on the space shuttle Columbia. On 6 May 1993, after 10 days in orbit at about 300 km altitude, 160 revolutions around the Earth and 6.7 million flight kilometres, the D-2 mission successfully ended. Sixty-two of the 89 scientific experiments carried out on the mission had been developed in Germany; of the remaining 27 experiments, France had developed 7, Denmark and Japan had each developed 4, Italy had developed 3, Belgium, the Netherlands and the United States had each developed 2 and Spain, Sweden and Switzerland had each developed 1. The D-2 mission was a truly international mission covering all scientific topics, including materials science (37 experiments), biology (18), human physiology (24), technology (2), Earth observation (2), astronomy (1), amateur radio (1) and even experimental subsatellites (4).

54. Brazilian space activities, coordinated by the National Institute for Space Research (INPE) of Brazil, will significantly expand in the near future. On 9 February 1993, an environmental data collection satellite, Satellite de Coleta de Dados (SCD-1) was successfully launched by a Pegasus vehicle into a low-Earth orbit with an inclination of 25° in order to provide adequate coverage of Brazil and particularly the Amazon region. A second satellite (SCD-2) will be ready to be launched into a similar orbit by late 1994.

55. Based on the experience of Satellite de Coleta de Dados, a more complex remote-sensing satellite equipped with a small camera is being developed by INPE. It should be able to transmit 200-metre resolution images in two visible spectral bands. It should be launched in 1996 with an indigenous launcher from Alcantara (in the Brazilian State of Maranhão) into sun-synchronous polar orbit at 640 km altitude. An identical satellite will be ready for a Brazilian launch in the period 1996-1997. China-Brazil Earth Resources Satellite (CBERS-1), the first remote-sensing satellite developed through a cooperative Brazilian/Chinese programme, is scheduled for launch by a Chinese Long March rocket in the period 1995-1996.

56. Between 1978 and 1991, small scientific satellites weighing about 50 kg were developed for the Magnetosphere-Ionosphere (MAGION) research programme in the former Czechoslovakia. Two more sophisticated MAGION-type subsatellites have been designed for the INTERBALL mission, which will study physical mechanisms of solar wind energy accumulation in the magnetosphere and dissipation of the energy in the auroral regions during magnetic substorms.

57. The INTERBALL mission consists of two pairs of spacecraft, situated in different orbits: one pair, the Auroral Probe, with an apogee of about 20,000 km; the other one, the Tail Probe, with an apogee of 200,000 km. Both orbits should have perigee heights of about 500 km and inclinations of 65°. Each pair of satellites consists of the main spacecraft of the Prognoz series, accompanied by a subsatellite of the MAGION type. The scientific objectives for the subsatellites are to separate time and space variations and to study spatial correlations and fine structures in the ionosphere and magnetosphere. Separation of the subsatellites will be controlled by small thrusters. The INTERBALL subsatellite payload and subsystems

have been developed and manufactured through an international cooperative effort involving Austria, Czech Republic, France, Germany, Poland, Romania, Russian Federation and Slovakia.

58. To develop a good model of satellite motion in the upper atmosphere, it is necessary to first have precise experimental data about atmospheric parameters and their spatial and temporal changes. An instrument that can measure all disturbing forces of non-gravitational origin (including atmospheric drag and lift) acting on a satellite is called an accelerometer, or a microaccelerometer if it is extremely sensitive. At the Astronomical Institute of the Czech Academy of Sciences, an accelerometer with a cubic proof-mass is now under development. The device, which is called MACEK, was tested in orbit in June 1992 on board the recoverable Resource F satellite.

59. The ultimate goal is to place the MACEK accelerometer on a dedicated satellite where it will be possible to get precise data on the atmospheric density distribution and variation. An opportunity to reach this goal is being presented by the Central European Satellite for Advanced Research (CESAR) project, undertaken in cooperation with Austria, Czech Republic, Hungary, Italy and Poland. The project is in the final stage of phase A, which involves agreeing on details of instrumentation, telemetric systems and orbit selection. The launching of the satellite to study the physical properties of the near-Earth environment is scheduled for 1997.

Note

1/ Official Records of the General Assembly, Forty-eighth Session, Supplement No. 20 (A/48/20), para. 80.

Annex

SCIENTIFIC AND TECHNICAL PRESENTATIONS TO THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE AT ITS THIRTY-FIRST SESSION*

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*This has not been formally edited.

I. SYMPOSIUM ON SPACE APPLICATIONS FOR DISASTER PREVENTION, WARNING, MITIGATION AND RELIEF

A. Space Applications for Disaster Prevention, Warning, Mitigation and Relief - The European Approach

1. After 35 years of space research, satellite Earth observation is widely used in applications for disaster prevention and warning. A large variety of disaster or catastrophic events occur frequently around the globe due to natural phenomena or man made activities. The observation of these events requires a wide scope of spatial and temporal scales. Short-term observations are used to monitor events such as floods, forest fires, typhoons, and earthquakes while long-term observations are required for the monitoring of phenomena such as desertification, deforestation, global warming and sea level rise.

2. Observation from space, with its continuous monitoring capability and global, repetitive coverage, offers a number of advantages compared to other techniques. Digital data sets also facilitate the observation of rural and remote areas over difficult terrain and provide consistent data sets, which are important for thorough analyses.

3. Very demanding observation requirements, particularly in terms of repetivity and spatial resolution, are required of Earth observations systems due to the wide variety of possible disasters and their random occurrence and the fact that they occur more often in certain seasonal periods and geographical zones. It is also of great importance for these systems to have all-weather observation capability.

4. The introduction of new technologies is sustaining and improving the effectiveness of such systems, but there is still no operational satellite system that is specifically dedicated to disaster monitoring. In the context of the establishment of a worldwide system for this purpose, Europe, through the European Space Agency (ESA), along with China, India, Japan and the United States of America, is playing a major role in deploying Earth observation satellites to be used for disaster warning and environmental monitoring.

5. ESA systems dedicated to these functions include the geostationary meteorological satellites of the Meteosat series and the polar-orbiting ERS series. The utility of ERS-1 data for monitoring disasters or catastrophic events has already been demonstrated on various occasions and will be increased in fields such as atmospheric chemistry and monitoring of land surface processes with the launch of ERS-2. The SPOT series of satellites, operated by a private company, provides high resolution optical images of the Earth's surface and the joint France-United States Topex-POSEIDON satellite systems allows continuous monitoring of ocean topography.

6. The development of more advanced sensors that will provide higher ground resolution and a further spectrum for monitoring atmospheric chemistry processes, as well as several approved new programmes at the European and national levels, will further enhance international capabilities to monitor and mitigate catastrophic events.

7. To meet future challenges and needs, it must be noted that spaceborne instruments can provide useful, and in many cases, unique data for the observation of disasters and should be supplemented by other data often made available via models. Future plans indicate that digital data will be more widely and effectively used as model assimilation techniques advance.

B. The Use of Space Technology for Understanding and Predicting Earthquakes and Volcanic Eruptions

8. The last 30 years have witnessed significant technological advances that have had an enormous impact on our daily activities and have considerably enhanced our living conditions. The sciences, particularly the Earth sciences, have also progressed in the same period and we can now observe and understand the Earth in its entirety. The tectonic plate model explains the origins of earthquakes and volcanic eruptions but even so, we are scarcely any better equipped to deal with the effects of telluric disasters than our ancestors were to cope with those devastating eruptions.

9. The construction of earthquake-proof buildings and installations does of course greatly reduce the potential risk of material damage and loss of life caused by earthquakes. However, these techniques are expensive and it hardly seems feasible to use them to rebuild all the cities located in high-risk areas around the world.

10. It could be said that seismic and volcanic risk is greater now than in the past, particularly due to the extremely high concentration of populations in urban areas. Due to population and building density, urban regions are more vulnerable to telluric disasters than are rural areas and the warning signs are harder to detect because of development on and below the ground and the higher level of noise generated by human activity.

11. Moreover, even though technological progress has reduced the risk of post-earthquake fires, such as those in San Francisco in 1906 and Tokyo in 1923, it has led to a proliferation of installations, such as dams, oil and gas storage facilities and, above all, nuclear power stations, whose destruction could have far more serious repercussions. Earthquakes are undoubtedly, among the most lethal, costly in economic terms, and threatening of the natural disasters to which our planet is prone.

12. For many geophysicists, the prediction of natural disasters can now be seriously envisaged, obviously on a short-term basis in the case of volcanic eruptions and, perhaps, also fairly rapidly in the case of earthquakes. An encouraging indication of such progress is the proliferation of observations of signals and events that are associated with earthquakes and volcanic eruptions. It must be noted that the knowledge gained about the deformation in the Earth's crust is one of the fastest developing areas and makes extensive use of space technology.

13. The acknowledged existence of some successful short-term predictions of earthquakes and volcanic eruptions, and the constant improvement in long-term prediction capabilities are also encouraging indications of current developments in these research fields. The most celebrated example is the prediction of the Haicheng (China) earthquake, which occurred on 5 February 1975. However, the tragic outcome of the Tangshan earthquake in 1977, which killed over 500,000 people in an area only a few hundred kilometres from Haicheng, shows how limited current prediction methods are.

14. The method used in Haicheng was based, like most short-term predictions, on an empirical analysis of a very large number of observations made systematically over nearly 10 years. Taken together, these observations revealed anomalies in the spatial distribution and current space missions have clearly shown the ability of satellites to make repeated observations over long periods of time on a scale that is difficult to achieve through ground observations.

15. Satellites are therefore essential for monitoring high-risk areas around the world. A satellite in polar orbit makes one complete orbit in about 100 minutes. It is thus possible to have global coverage of the Earth in a few days. The ERS-1 satellite is now able, with an appropriate data-gathering system, to photograph

the entire planet's surface with a resolution of a few metres in 35 days. Of course, the use of satellites means that some of the crucial parameters mentioned earlier can be observed from space.

16. As far as seismic risk mapping is concerned, there is a simple rule particularly in intra-continental areas: earthquakes always occur on a pre-existing fault. Risk mapping thus consists of mapping all faults. Since their launching, the SPOT and LANDSAT remote sensing satellites have proved to be remarkably well-equipped with fault-mapping tools. In some circumstances high-resolution space imaging can even be used to measure the cumulative displacement of the more active faults and thus to deduce displacement rates. Hence the current degree of resolution of the SPOT pictures permits precise measurement of changes in river beds and recent sediments.

17. In the case of volcanoes, the extent of this phenomenon and the places where it appears are straightforward criteria for assessing risk. In order to measure the volumes of lava emitted, and variations in the timing of these emissions during an eruption – two key parameters for determining volcano dynamics – remote sensing methods again represent a powerful tool.

18. New techniques using Synthetic Aperture Radar (SAR) data are undergoing active development and the images produced by ERS-1 satellite data are ideal for predicting volcanic eruptions. This technique enables one not only to measure movements of the ground, but also to identify exactly the topography of the volcanic formations and the direction and ruggedness of the slopes. These are crucial factors in anticipating the location and extent of lava flows.

19. In a few specific active zones, such as California, United States, these deformations are regularly measured within distances ranging from one kilometre to several hundred kilometres, in order to distinguish local influences associated with the seismic cycle. It is only by using spatial techniques that these measurements can be made over such a range of distances. For the longest-range measurements, the techniques used are satellite laser telemetry and interferometry. At the local level, the preferred method is the application of Global Positioning Systems (GPS) which are now accurate to within a centimetre and can produce a detailed description of the deformation in the vicinity of the fault.

20. Landslides represent another major geophysical risk. The instability of mountain slopes, resulting in landslides, is usually caused by the gradual erosion of mountains and massifs. The risk is increased by the weathering of rock and soils, especially as a result of water infiltration. But the biggest landslides are often of tectonic origin, and are caused by movement in active faults and are sometimes even set off by a nearby earthquake. Hence, they may be an aggravating factor in the destruction caused in an earthquake zone.

21. Here again, space geodesy, especially SAR interferometry, is an ideal technique for monitoring these phenomena. Presently a trial survey of a landslide in the Alps is being conducted using SAR images from ERS-1. In this survey, a range of ground movements varying along the landslide, from 0.2-1.0 cm per day has been noted.

22. Other kinds of sensors, installed or programmed on satellites, which can provide crucial information about the activity and potential risks of volcanic activity are also of interest for predicting catastrophic events. The first type consists of visible imaging systems such as SPOT and LANDSAT, which provide images of volcanoes and their features by combining channels. The others are mainly infrared and ultraviolet measuring systems for estimating the surface temperature of volcanic formations and the volumes of sulphur dioxide emitted by volcanoes. Geostationary satellites which take very low-resolution photographs, in both visible and infrared bands, are also a vital source of information for studying the risks caused by emissions of aerosols and gases from volcanoes.

23. Every year there are several dozen earthquakes in the world of a magnitude greater than 6.5 on the Richter scale. The understanding of this phenomenon is still far from complete, chiefly because of the small amount of data available. In fact, in most cases the only geophysical observations made are recordings of seismic signals taken at a distance of several thousand kilometres from the source.

24. Mechanisms for the rapid deployment of networks supported through local seismic monitoring stations in the affected zones have been established in a number of countries allowing them to study the characteristics and distribution of aftershocks which also represent a major source of information and are very often responsible for additional damage and casualties. But the deployment of these networks is often not undertaken until several days after the first tremor, and depends to a great extent on the meteorological and political conditions in the affected zone.

25. At the same time, it is already possible to build automatic, non-recoverable seismic monitoring stations which are easy to install. The data gathered can then be transferred via the EUMETSAT, INMARSAT and INTELSAT communications systems. In the very near future the number of such networks will increase as will the volume of data to be transmitted. Furthermore, the need to transmit in "real time" will also grow in line with improvements in the ability to predict seismic disturbances. In this context, satellites can play a key and vital role in monitoring, predicting and mitigating the consequences of natural disasters.

C. Remote Sensing of Severe Weather Events

26. In the past decade the United States National Oceanic and Atmospheric Administration (NOAA) has established a temperature and moisture sounding capability in its new polar and geostationary satellite programmes. These systems have supplemented the visible and infrared imagery previously available. Applications of these technologies include temperature and moisture analyses for weather prediction, analysis of weather stability, estimation of tropical cyclone intensity and position, and global analysis of clouds. The use of satellites also extends to NOAA's climate programme which allows the computation of models on the effect of aerosols and greenhouse gases and possible global warming trends.

27. In addition to imaging the Earth's atmosphere with visible reflected and thermal emitted radiances, the observations are used to calculate the atmospheric temperature for obtaining moisture profiles, surface temperatures and cloud parameters. Many of these applications are pertinent to operational short-range forecasting. The quality of the models developed indicates that there is cause for optimism in the operational application of satellite sounding products and it has been recognized that the applications of these data at present has not been exhaustive.

28. Wind measurements remain the most important factor for the prediction of hurricanes. In a recent study of the past six hurricanes seasons in the United States, these satellites derived wind analyses which produced a 10 per cent reduction in the mean forecast error in hurricane track prediction and contributed significantly to early monitoring of such catastrophic events.

29. Microwave observations from the current NOAA polar orbiting satellites have also been successfully used to locate tropical cyclones and to estimate their surface intensity. By penetrating the cloud cover associated with tropical cyclones, it is possible to capture the characteristic upper level warm temperature anomaly. This valuable information in the prediction of storms is increasingly being sought by the meteorological community to supplement reconnaissance flight and other conventional data.

30. The analyses of temperature and moisture for severe weather monitoring and prediction can also be conducted with the assistance of polar orbiting and geostationary satellites. Timeliness and the continuity

of data, as well as a proper understanding and interpretation of the data derived, are essential for the operational use of satellites in forecasting catastrophic events.

31. It is apparent that the existing database from NOAA's polar and geostationary satellites is an integral part of the ongoing investigation of the Earth and its atmosphere. While future observing developments will enhance the capability to probe the Earth system, the data from the current series of satellites are already proving to be a useful tool for the understanding of the global habitat and coming changes.

D. Desertification and its Management in China

32. Desertification is defined as land degradation in arid, semi-arid and dry sub-humid areas. It is caused by adverse human activities and climatic changes. It causes degradation of grasslands and reduced soil fertility. The processes involved include wind and water erosion, salinization, waterlogging and chemical pollution.

33. Based on a desertification assessment made by the United Nations in 1991, 25 per cent of the Earth's surface is affected by desertification. Adverse effects of human activities are the main causes. Degradation of the land is caused by overgrazing, felling of forests, irrational agricultural uses and activities related to industry and mining. Therefore, desertification or land degradation is recognized as a global environmental issue and attracts attentions from all over the world. China, with it's vast territory, various physical environments and huge population, has had to master the problem of desertification for many centuries. Consequently, desertification and its proper management has been proceeding on a very large scale

34. A comprehensive management strategy and a series of engineering and biological measures has been implemented. Measures include slope modification, valley construction, soil-erosion protection, tree or shrub shelterbelts and other agro-measures, in order to increase surface roughness of farmlands so as to decrease sheet erosion. With regard to desertification and its management, the use of satellites and remote sensing data is not only feasible for detecting changes occurring in the environment but has far better results than other methods.

35. For example, a map of erosion types and erosion intensity has been compiled through the use of LANDSAT Thematic Mapper (TM) and Multi-Spectral Scanner (MSS), and Tunable Laser Spectrometer (TLS) false colour composite satellite images and colour infrared aerial photos. In addition, another map was developed by combining geographic analysis with remote sensing techniques, interpretation and land survey, which allowed the evaluation of erosion intensity. The use of such maps, created with the help of space technology, can lead to a better understanding of short- and long-term processes of erosion and lead to improving countermeasures against these problems.

E. Floods and Droughts

36. For as long as humanity has been present on the Earth, it has been vulnerable to extremes of climatic fluctuations. At present, there is enormous concern about the changes that are occurring on the surface of the Earth and in its atmosphere, primarily due to human intervention with nature. These changes are likely to alter the hydrologic cycles which have a profound impact on the occurrence of floods and droughts. Developing countries, which are less equipped to recover from these events, are also the least prepared and protected and, as a result, suffer the most devastation from them.

37. Over the last four decades, in Bangladesh alone, more than 250,000 people have died due to natural disasters, primarily floods. In India, nearly 25 per cent of the population lives in drought and flood prone areas.

38. Floods and droughts occur so frequently, and cause so much devastation that economic development, social stability, and environmental quality are adversely affected all over the world. Although these phenomena are inevitable, it is possible to reduce their impact through effective action plans and more efficient management of resources.

39. Space technology has already made substantial contributions to every aspect of flood and drought management, including preparedness, prevention and relief. While satellite communications have significant potential for real-time dissemination of information and early warning, Earth observation satellites enable the user to continuously monitor atmospheric and surface parameters attributed to these phenomena. The considerable knowledge gained in the operational use of space technology for management and mitigation of floods and droughts should in the near future provide viable technological solutions to these problems.

40. Though several countries, including some developing nations, are using space technology to address these problems in their respective regions, many developing countries do not yet have the necessary infrastructure and required level of trained manpower to absorb this type of technology for direct problem solving. It is equally important to bridge the "knowledge gap" between those who can use space technology and those who cannot, through meaningful and active international and regional cooperation schemes to ensure an effective management of floods and droughts at all levels.

41. The experience in India, for example, has shown that the combination of telecommunications and meteorological satellites can be of great importance in predicting catastrophic events. While the capabilities of communication satellites in disaster warning, data transfer and relief operations have been furthered with the advent of Very Small Aperture Terminals (VSATs) and Ultra Small Aperture Terminals (USATs), meteorological satellites are providing vital information on clouds, temperature, humidity, wind characteristics, etc. These derived imageries are particularly useful in identifying cloud systems over the ocean, for cyclone tracking, intensity assessment and prediction of storm surges. Outgoing long-wave radiation, along with precipitation data provide valuable input to numerical weather prediction models.

42. Besides providing input for quantitative estimation of precipitation, geostationary satellites have become increasingly helpful in the collection of data on rainfall and river stages in remote and uninhabited locations. The implementation of a local disaster warning system, consisting of a number of disaster warning receivers to provide timely warning in the coastal villages of India, has been another innovative application. One of the most notable uses occurred during the cyclone that hit the Andhra Pradesh coast in 1990, and which enabled the government to evacuate over 170,000 people, thus saving thousands of lives in this area.

43. In Bangladesh, a nationwide flood forecasting and warning service has been developed through the integration of satellite derived cloud pattern data and field data. Significant achievements have also been made in satellite-based precipitation forecasting and flood management by China. In Nepal, NOAA images are used for flood warning in the entire region. The successful launching and operation of the second generation of Indian INSAT satellites has greatly improved space technology applications in the fields of weather monitoring and disaster warning throughout the region.

44. Throughout the region, satellite-derived vegetation indices, which are sensitive to vegetation stress are now being continuously used to monitor drought conditions on a real-time basis. These indices help decision-makers to initiate strategies for recovery by changing crop patterns and various agricultural practices. The use of meteorological satellite data to assess the spatial and temporal inadequacies of rainfall at critical crop stages and subsequent assessment of crop status also provides an excellent drought monitoring mechanism.

45. A remote sensing-based National Agricultural Drought Assessment and Monitoring System (NADAMS) for countrywide monitoring in India has been developed and is being used for operational monitoring. In the first phase, the system integrates rainfall and aridity anomalies with other data sets in order to provide realistic assessment of droughts. Bi-weekly drought bulletins for drought prone districts of the country are issued to concerned user agencies at all levels so that they may take any necessary action. Based on user feedback, the second phase of NADAMS was launched in 1992. This phase includes detailed monthly drought assessment in terms of spatial variability and impact on crop/fodder production.

46. Although a number of satellites currently provide data covering a wide spectrum of the Earth's environment, it must be noted that no single satellite mission can provide the full range of measurements needed to meet the requirements for efficient flood and drought management. There is thus a need for using complementary and supplementary data from different satellites requiring data compatibility in terms of formats and calibration. Having the necessary uninterrupted data supply within short turn around time requirements is a major "bottle neck" which needs to be solved through proper international cooperation.

47. Because of the direct relevance of space technology for addressing problems related to floods and droughts, there is an urgent need for appropriate technology transfer, and the adaptation of this technology and its assimilation in the existing socio-cultural environment of developing countries. Agenda 21 (of the United Nations Conference on Environment and Development) advocated the transfer of technology including know-how, procedures, goods, services and equipment, as well as organizational and managerial procedures. The use of space technology for flood management in China, and the long-term drought proofing in India, are some useful examples which could be transferred to other nations that have similar problems.

48. Several developing countries are currently using space technology to address the issues related to flood and drought management in their regions. In view of this, the International Decade for Natural Disaster Reduction assumes paramount importance for mobilizing global efforts to improve the utilization of space technology for better management and mitigation of floods and droughts.

F. Overview of FAO Remote Sensing Activities

49. The world food crisis in the early 1970s proved to governments, international organizations and the general public that there was a real need for a continuous flow of up-to-date information on the outlook of the supply of man's basic foods. In 1975, as a follow-up to the 1974 World Food Conference, the Food and Agriculture Organization (FAO) of the United Nations established the Global Information and Early Warning System (GIEWS) on Food and Agriculture. The primary purpose of GIEWS is to monitor food supply and demand conditions on a global scale, identify countries or regions where food shortages are imminent and assess possible emergency food requirements. As such, GIEWS is the only comprehensive international source for information on current and prospective food supply/demand situations in all countries of the world.

50. Since 1976 FAO has actively been developing and testing the operational use of data from environmental and Earth resources satellites for improving the information bases of GIEWS and the Desert Locust Plague Prevention Programme at the international, regional and national levels. Starting in 1977, Meteosat imagery was analyzed visually for the monitoring of rainfall over Africa.

51. In 1985, a project was initiated to develop and implement a highly automated satellite data acquisition, production and distribution system. This system, the Africa Real Time Environmental Monitoring Information System (ARTEMIS), became operational in August 1988 and is still in service.

52. For the timely supply of information on growing conditions and vegetation development, the ARTEMIS system relies on two data sources: the NOAA series of satellites and Meteosat. The operational production

at present covers Africa and the Near East and archived data goes back to 1981. This archive is continuously updated and becomes more and more valuable, not only for early warning purposes, but also for more general environmental studies.

53. All the data produced by the system are disseminated directly to a large number of users, both at FAO Headquarters as well as in Africa. The Headquarters users include the GIEWS and the Desert Locust Plague Prevention Group. Users within Africa included virtually all national and regional early warning systems but depend mainly on pouch or courier services, which can cause undesirable delays. However, electronic transmission of the data to certain locations in Africa is now taking place via electronic mail facilities and the Direct Information Access Network for Africa (DIANA) system.

54. DIANA was developed by ESA in collaboration with FAO and currently is comprised of an up-link station in Italy and three microcomputer-based receiving stations in Ghana, Zimbabwe and Kenya. Using these electronic communication channels, when available, African users of ARTEMIS information are able to receive digital data without any delay.

55. Recent developments include the increased use of ARTEMIS data on standard microcomputers, the increased use of ARTEMIS data at the national and regional level in Africa and the increased (near) real-time access to Meteosat and NOAA derived products. Local reception and processing facilities and telecommunication developments such as DIANA and the increasing availability of electronic mail are also facilitating the use of ARTEMIS data.

56. In the future ARTEMIS will, in addition to providing information to Headquarters users, increasingly focus on the provision of expertise and coordination in the fields of training, calibration and further development of application modules and low-cost systems, as well as providing, through continuation of the operational production of its routine maps, a back-up to local production facilities. Furthermore the development of regional programmes for environmental monitoring using satellite remote sensing, thereby putting the early warning application in a wider context of environmental management, will be of great importance.

G. GEOWARN – Global Emergency Observation and Warning

57. Due to the increase in global population as well as in population densities, the impact of natural disasters on humanity is becoming more and more severe. Although current space-based, air-based, and ground-based technologies enable mankind to mitigate the effect of disasters, no worldwide disaster monitoring system has to yet been put in place.

58. Consequently, students of the International Space University developed in a design study the Global Emergency Observation and Warning (GEOWARN) system which could serve as a worldwide institution for filling the current gaps of development in fields such as Earth observation, data processing, information dissemination, and telecommunication support for disaster warning and relief. The system would be open to all nations for humanitarian purposes and may be implemented over the next decade. GEOWARN would primarily provide global disaster warning, notification and relief support services. Detailed disaster information, the facilitation of emergency communications and the provision of interface personnel would be the main target of the system. To this end, GEOWARN would strongly interact and cooperate with existing organizations such as FAO and WMO.

59. In order to arrive at effective and economically reasonable system requirements, the highest priority natural disasters such as floods, hurricanes, earthquakes, droughts, insect infestations and crop diseases were defined by the multinational group of students. To effectively monitor these types of disasters, it was proposed to establish a data gathering system that would consist of internal installations, including six Earth-

observing LEO satellites, 30 remote sensing aircraft, and data archives, and would incorporate external facilities such as the existing meteorological and seismological centres, databases and research institutions.

60. The GEOWARN system's brain would be located in five relatively autonomous centres, each providing GEOWARN services to a specific part of the world. In these centres the data would be collected, processed, interpreted, and archived. The GEOWARN system's interconnection as well as the connection to the outside world may be accomplished by a flexible communication net consisting of ordinary post and telegraph lines, INTERNET, fixed INTELSAT, and mobile INMARSAT links.

61. The primary users of the GEOWARN system would be the respective governments affected by disasters and the Secretariat of the United Nations. They would be notified immediately in times of impending disasters. Secondary users would have to be explicitly authorized by the primary users to request and receive warning relief information. This group may include local authorities, local emergency agencies, relief agencies, church organizations, and the media. Tertiary users may gain access to the GEOWARN database and archives for humanitarian research activities and would include universities and research institutes.

62. GEOWARN would be an international, non-profit, politically neutral, and non-discriminatory organization with governments as shareholders. The organization would consist of an Assembly of Representatives on a one-nation, one-vote basis, a Board of Directors with a voting power proportional to investment share, and a Directorate which would coordinate the centres. It is impossible to predict how many lives GEOWARN may save. However, it was expressed by the student body that if only 0.5 per cent of the economic damage caused by disasters yearly could be prevented, then the estimated average annual cost of the system, $470 million, would be justified.

H. Synthesis: Space Applications for Disaster Prevention, Warning, Mitigation and Relief

63. At any given time, tens of millions, even hundreds of millions of people are at risk from some form of natural disaster. The material cost of such disasters has been calculated to be tens of billions of dollars annually and not only people in developing countries are at risk. Therefore, in the field of disaster prevention, the active interest and help of all concerned entities is essential for limiting the human and economic costs of natural disasters.

64. There are existing plans for maintaining and greatly extending the capacity to make measurements from space, and new instruments which are more flexible and offer better results are continuously being developed. It is also encouraging that more attention is apparently being given to the ground segment of such systems which traditionally represented the poor relation in many space programmes. This will help to improve and facilitate the processing of the vast amounts of data which are generated from spaceborne systems.

65. Connected with the space element, scientists are working to get the most out of existing sensors and to determine what improvements can be made to future instruments. End-user scientists, geologists, geographers, meteorologists, soil scientists, irrigation and drainage engineers, and oceanographers, who wish to improve their understanding of natural disaster phenomena, are increasingly using space technology to enhance their capabilities to predict natural disasters.

66. Cooperation between new end-users and more traditional users is essential if the contribution which space can make is to be maximized. Space techniques can not only provide increasingly accurate and sophisticated measurements, but can interrogate remotely situated sensors on the ground and transmit warnings and other large packets of information to multiple addresses.

67. The real difficulties arise with the integration of different national and international ground infrastructures. The detection of an earthquake or the prediction of the track of a hurricane may be feasible but it serves little practical purpose if the people affected are not warned immediately and either evacuated or given protection. The real application and pay-off in these new techniques are dependent on integrating them into effective action on the ground.

68. The major aims of using space applications for disaster prevention, warning, mitigation and relief can be seen in a continuous education about what space techniques can do and cannot do, in the better exploitation of existing satellite data and their combination with non-space data into useable and timely information and management schemes. Finally methods, technologies, hardware and software used should meet end-user needs and fully incorporate their own capabilities.

II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

A. Space Debris Observation and Modelling

69. During 36 years of orbital operations, more than 23,000 individual trackable objects have been placed into orbit around the Earth. As of early 1994, more than 7,000 of these objects remained in orbit. In order for the United States Space Command to be able to track these objects, they must have dimensions greater than 10 cm in low Earth orbit (LEO) and 100 cm in geostationary orbit (GSO). In addition, there is estimated to be a population of smaller objects (1 cm < d < 10 cm) which exceeds the number of trackable objects by at least an order of magnitude, and which is capable of causing the catastrophic breakup of operational satellites. A further, even larger population of smaller debris objects (d < 1 cm), though less likely to cause a catastrophic breakup of a satellite, can cause a significant degradation in satellite system and subsystem performance. The collision hazard presented by the debris is due to the high energy of impact: encounter velocities can be of the order of 10-15 km/s in LEO.

70. At present, the evolution of the debris population is beyond human control. Only 22 per cent of all payloads currently in orbit are operational. These functioning payloads represent only 5 per cent of the more than 7,000 objects tracked on a regular basis by the United States Space Command. Redundant launch vehicle upper stages represent an additional 16 per cent of the population, mission-related objects contribute a further 12 per cent, and fragments from breakups make up the remaining 45 per cent. Therefore, the behaviour of 95 per cent of the trackable objects and all of the smaller size debris population, cannot be controlled.

71. German activities in the field of space debris cover a wide range and are supervised by the German Space Agency (DARA). German research activities can be grouped under the following headings:

- methods of debris detection;
- modelling of space debris;
- trend analysis;
- investigation of hypervelocity impact phenomena;
- test and numerical simulation;
- development of debris protection systems;
- debris prevention and removal.

72. German research activities are either conducted on a purely national basis or are funded under contracts with ESA's European Space Research and Technology Center (ESTEC) and the European Space Operations Center (ESOC). The nationally funded research activities are largely concentrated in the Institute for Space Flight Technology and Nuclear Reactor Technology of the Technical University of

Braunschweig (IfRR/TUBS) and the Research Establishment for Applied Science (FGAN) under research contracts awarded by DARA and ESA. Most of the work has been performed in close and successful cooperation with researchers from the United States National Aeronautics and Space Administration (NASA)

73. Assessing the present and future risk to all space objects requires the use of models. The ESA Meteoric And Space Debris Terrestrial Reference Model (MASTER) has been developed by IfRR under an ESOC contract. The scope of the model covers man-made and natural objects larger than 0.1 mm in altitudes below 2,000 km. Analytical break-up models are used for the individual generation of the untrackable debris population for the known on-orbit fragmentations (116 up to July 1993). The observable part of the population is considered through ground-based radar measurements. For each generated population member, information is retained on its origin, mass, size and orbit. Flux information is resolved with respect to the impactor source, its mass, the impact velocity, impact azimuth angle, impact elevation angle and the position of the impact occurrence along the target's orbit.

74. The analyses carried out on samples returned from the Long Duration Exposure Facility (LDEF) satellite underline the existence of a large number of small debris particles orbiting on highly elliptical orbits with low inclinations. In addition, the existence of small particles on sun-synchronous orbits (near-circular with high inclinations) must also be assumed to explain the observational data on LDEF's leading surface. From further analyses, which allow for the conversion of crater frequencies into particle fluxes, it can be assumed that present orbital debris models are underestimating the environment in the 0.1 mm size range by a factor of 2 to 3. Hence, the impact data to be gained by analysis of ESA's European Retrievable Carrier (EURECA) platform and the Hubble Space Telescope's solar array will be of major importance in view of this topic.

75. In order to more precisely assess the long-term effects of orbital mechanics for the purpose of space debris modelling, a special computer code (LOPEX) has been developed at IfRR/TUBS. This code allows for analyzing the behaviour of different types of orbits (from circular to highly elliptical in various altitude regimes) over periods up to several hundreds of years taking into account the relevant orbital perturbations with a sufficient degree of accuracy. Hence, it can be used to evaluate the effectiveness of storage concepts (e.g. graveyard orbits) for those kinds of orbits, which will not become subject to direct debris prevention measures due to technical and economical reasons. The interaction of debris on geostationary transfer orbit (GTO) and other highly elliptical orbits within the geostationary ring can also be analyzed.

76. The objective of a NASA/FGAN joint research investigation is to characterize and compare debris shape, size, intrinsic motion, mass, and orbital lifetime from different types of breakups, for example, from collisions and explosions. At present, radar data on 30 debris objects (size larger than 50 cm) are being analyzed. A statistical analysis of measured radar cross section (RCS) and a comparison with NASA results derived from effective areas of infrared, optical, and radar measurements has also been started.

77. ESA has been actively addressing the space debris issue for several years. Its early concerns were the uncontrolled re-entry of spacecraft (e.g. the nuclear powered Cosmos 954 and Skylab space station), collision risk in the geostationary orbit (GSO) and ensuring the safety of manned spaceflight. In 1985, a workshop was held at ESOC to discuss the problem of uncontrolled re-entry of risk objects. In 1986, the Director General of ESA established the Space Debris Working Group (SDWG) with a mandate to assess the various issues of space debris. Based on the findings and conclusions of the SDWG (published in ESA's Report on Space Debris, ESA-SP 1109), the Council of ESA in 1989 defined the Agency's objectives in the field of space debris and approved a plan of activities, which includes as a main element, a space debris programme. In 1990, the ESA Space Debris Advisory Group (SDAG), composed of experts from ESA member states, was created to advise the Agency in all matters related to space debris.

78. The purpose of ESA's Space Debris Research Programme is to reach a better understanding of critical issues and to prepare for future programmes. It covers three main areas:

- Knowledge of the terrestrial particulate environment;
- Assessment of the risk posed by space debris; and
- Protective and preventive measures.

79. Europe has no system for space surveillance, i.e. the systematic monitoring of all space objects. However, some facilities exist for the tracking of selected objects. They comprise 34-m parabolic antenna radar at FGAN in Wachtberg-Werthoven, Germany. With this powerful radar, which operates in L-band and Ku-band providing narrow-band as well as high resolution radar data, space objects can be tracked over large areas of Europe. Research on the physical characteristics (RCS, shape, mass, altitude) of space objects is carried out. Upon re-entry of risk objects, radar and optical stations in France also provide data for re-entry predictions. A survey on the use of ground- or space-based optical and infrared sensors for the detection and tracking of space debris has been carried out in the United Kingdom of Great Britain and Northern Ireland. Efforts are also being made to improve European ground-based observation capabilities with radar and optical sensors. A one-metre Zeiss telescope is planned to be installed on the Canary Islands as an optical ground site for the Silex experiment within the ARTEMIS project. After appropriate modifications and upgrades, the telescope can also be used for space debris observations, particularly for objects in GTO and GSO.

80. Under a contract with the Unit for Space Science at the University of Kent in Canterbury, England, ESA has established the DISCOS space debris database at ESOC in Darmstadt, Germany, for its own use and for that of member state institutions. It supplies information on the currently catalogued objects and is a basis for risk assessments and understanding of the evolution of the space debris environment. DISCOS contains as major elements the NASA "two-line orbital elements" which are regularly updated, the NASA Situation Report, the Royal Aircraft Establishment (RAE) Table of Earth Satellites and information on satellite fragmentation history.

81. Based on existing meteoroid and debris models, the particulate flux near a space vehicle can be modeled. ESA analyses show that the current population of debris does not represent an immediate and excessive danger. For example, during a five-year period, the chance of an ERS satellite colliding with a 1 cm or larger particle is 1 per cent to 2 per cent. However, the risk of collision with debris is steadily growing. Of most concern are the long-term prospects in low-Earth orbit (LEO) and in GSO, the two most heavily used and endangered regions in space.

82. Theoretical models of debris generation caused by the disintegration of objects or by collision between objects have also been conducted in other countries, for example in India. These studies are aimed at better understanding the untracked debris environment and predicting collision probability for operational spacecraft. In spite of different initial assumptions, their conclusions are in general agreement.

B. Space Debris Mitigation Techniques

83. An object is removed from orbit when either atmospheric drag reduces its orbital energy or it is actively de-orbited through a propulsive manoeuvre or retrieval. Atmospheric drag, however, is only effective at removing objects from orbit at altitudes below 600 km. Above this altitude the atmosphere is too rarefied to return objects to Earth within an acceptable time. It is unrealistic to propose, or expect, active retrieval of redundant objects currently in orbit. The objective must therefore be to prevent the debris environment from further deterioration through debris mitigation measures applied to future missions. If these measures are implemented, the onset of cascade fragmentation is prevented and thereby ensured access to near-Earth space continues. In considering ways to control debris deposition, one must guard against any limitation on

the use of Earth orbit by responsible operators, and seek only to restrict design and operational practices when they can be shown to have a significant detrimental effect on the orbital environment.

84. A technical framework must be established to assess the hazard that future debris will represent to the orbital environment. This may then form the basis of any initiatives to control the debris deposition into orbit. The assessment of detrimental environmental impact must be applied to all objects injected into orbit by the mission which become debris. This will include the payload and launch vehicle at the end of their operational lifetimes. Existing initiatives aimed at controlling the deposition of debris into Earth orbit have only been linked to qualitative statements which are not easily applied to regulatory measures. The quantitative assessment of the potential detrimental impact of a space mission is easier to apply to any initiative to control space debris, but even in its simplest form, this is a complex, multidimensional problem.

85. According to an expert from the United Kingdom, a quantitative assessment of detrimental impact will permit the environmental hazard to be characterized and "acceptable" levels of degradation to be identified. No measure of detrimental impact in this context, however, currently exists. Terrestrial pollution and permissible levels of degradation, are not assessed directly in terms of the deterioration in the environment, but indirectly in terms of the level of degradation that the ecological system can support without suffering harmful consequences. It is proposed that an assessment of the detrimental impact of a space mission can be measured in a similar fashion, in terms of the collision hazard it presents to the population of operational satellites residing in intersecting or neighbouring orbits.

86. The probability of collision between an object injected into Earth orbit and the population of operational satellites is an obvious parameter to use in quantifying the hazard. However, one cannot use collision probability alone. Account must also be taken of the most probable outcome of the collision, for example impact by a 1 mm object will have a less damaging effect on an operational satellite than collision with the upper stage of a launch vehicle. Therefore, a further parameter must also be included in this assessment related to the relative kinetic energy of the impactor, in order to represent the potential damage or performance degradation that can be caused.

87. In addition to being used for regulatory means, the quantitative approach which has been proposed by the United Kingdom can be used when considering the possible contribution of an operator to a compensation fund under the "polluter pays" principle. Thus, an operator could choose between adopting debris mitigation measures in the vehicle design or operational practices, or making a greater contribution to the compensation fund. If the detrimental impact assessment is applied to all debris objects associated with a mission, an operator may choose a launch system which makes the smallest contribution to the overall collision hazard for that mission. This should encourage launch vehicle operators to adopt similar mitigation measures in their design and operational practices in order to remain attractive and competitive in the launcher market.

88. The insurance industry will be keen to indirectly protect the future missions that they will underwrite by protecting the environment in which those assets will operate. Thus, a mission making a significant contribution to the collision hazard in orbit could be subject to penalty premiums, related to the detrimental impact of the mission. This would provide financial encouragement to operators to adopt appropriate debris mitigation practices in design and operations, or at least provide them with a cost trade-off between the two. The proposed quantitative approach therefore has two aims. The first is to encourage the adoption of debris mitigation principles in mission design by illustrating the cost benefits associated with such measures. The second and ultimate objective is to maintain unlimited access to orbit for all responsible users who wish to continue to exploit the commercial, strategic and scientific potential of near-Earth space.

89. ESA's spacecraft in GSO orbit are re-orbited into graveyard orbits at the end of their operational lives. In 1984, Geos-2 was boosted into disposal orbit 230 km above the GSO. In 1991, the satellites OTS-2 and Meteosat-2 were transferred to orbits 320 and 335 km above GSO. Later, Olympus and ECS-2 were also

inserted into disposal orbits. Similarly, the French space agency CNES re-orbited its Symphonie and Telecom-1A geostationary satellites.

90. However, re-orbiting can only be considered as an interim measure. Ultimately, complete removal from orbit must be considered. Further research with regard to the end of life disposition of GSO satellites will address the location of the disposal orbits and disposition of separated apogee boost motors. Coordination between space agencies is also required in the question of co-location of satellites on the same position of the GSO. For example, at 19° west longitude, Olympus-1, TDF-1, TDF-2 and TVSat-2 have all been assigned a common window of 0.1°. Computer simulations have shown that in case of uncoordinated station-keeping of four satellites, the expected time between close encounters of 50 m or less is 0.6 years. As this level of collision probability is unacceptable, optimized control schemes have been devised which are based on using slightly different orbital parameters for the collocated satellites. With separation by different eccentricity and inclination vectors, the collision probability can be substantially reduced. The penalty is a slightly higher propellant consumption for station-keeping.

91. Since the clean-up of debris is neither technically practical nor economically feasible at the present stage of technology, the thrust of ESA action is towards preventing the creation of debris. A study has been conducted to analyze debris production processes on a representative selection of space systems and to recommend technical measures for the prevention and reduction of space debris. The outcome of this study is used for the definition of clauses in ESA's Procedures, Standards, and Specifications (PSS) documents concerned with debris preventive measures.

92. As space debris is a global problem which only can be solved by a joint effort, discussions and cooperation among space agencies and related organizations are of paramount importance. Regular coordination meetings have been held between ESA and NASA since 1987. In 1993, the Inter-Agency Space Debris Coordination Committee (IADC) was created. Its members are ESA, entities form Japan, NASA and the Russian Space Agency. The primary purpose of the IADC is to exchange information on space debris research, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities and to identify debris mitigation options. In particular, the need was recognized to develop a common database of the space debris environment which will be supported by the surveillance networks and observation facilities of all four participants.

93. To mitigate the problem of space debris, space agencies have adopted some voluntary measures. For example, the French Space Agency (CNES) together with Arianespace instituted a policy of residual fuel venting from the upper stage of Ariane launchers in case of launches into low altitude circular orbits (SPOT-2, ERS-1 and Topex/Poseidon) to prevent explosions. Since flight V59, fuel venting of the third stage has also been conducted as a routine procedure regardless of the type of the target orbit.

94. Future CNES debris mitigation policy includes the following:

- The launcher may leave in orbit a maximum of one inert object (debris) per satellite launched;

- All objects left in orbit (whatever the orbit may be) must be fully pacified to prevent any further explosions after the end of mission. Active elements such as batteries or tanks containing residual propellant must reach a fully inert state after delivering the satellites to orbit;

- Last stage separations must be clean and explosive bolts and clamps must be trapped to avoid creation of operational debris;

- Solid propellant perigee kick motors that release aluminum particles are to be avoided; and

- All other stages must naturally re-enter the atmosphere or be de-orbited.

95. United States policy requires that space activities be carried out so as to minimize orbital debris. This policy requires each programme to conduct a formal assessment of its potential to generate orbital debris. A Handbook to support implementation of the policy is being prepared by NASA to reduce the time and costs for performing such assessments and to assure consistent standards and criteria across projects. This work is being sponsored by the Office of Safety and Mission Quality at NASA Headquarters. The NASA guidelines and supporting analysis tools in the Handbook are grouped into four general areas:

- Control of debris released during normal operations;

- Control of debris collision risk during mission operations;

- Post-mission disposal of space structures; and

- Analysis of ground footprints for re-entering structures and debris.

96. The guidelines were defined to limit the risk to operating spacecraft, either directly by limiting the amount of debris placed in the space environment or indirectly by limiting the amount of non-functional mass in large objects remaining in orbit and the probability of either explosive or collisional breakups. Because removal of objects from orbit using atmospheric drag is one of the mitigation measures recommended for LEO and highly eccentric orbits, the Handbook also provides support to assess the re-entry risk.

97. The problem of space debris is also being investigated by international organizations, such as the International Astronautical Federation (IAF) and the International Academy of Astronautics (IAA). IAA recently initiated a study to be performed by experts from its Committee on Safety, Rescue and Quality. The objectives are to evaluate the need and urgency for action and to indicate ways to reduce the hazards. This document, which was approved in October 1993 as an official IAA Position Paper, recommends for immediate application the following actions:

- No deliberate breakups of spacecraft which produce debris in long-lived orbits;

- Minimization of mission-related orbits;

- Safing procedures for all rocket bodies and spacecraft which remain in orbit after completion of their mission;

- Selection of transfer orbit parameters to insure the rapid decay of transfer stages;

- Re-orbiting of geostationary satellites at end-of-life (minimum altitude increase 300-400 km);

- Separated Apogee Boost Motors used for geostationary satellites should be inserted into a disposal orbit at least 300 km above the geostationary orbit; and

- Upper stages used to move geostationary satellites from GTO to GSO should be inserted into a disposal orbit at least 300 km above the geostationary orbit and freed of residual propellant.

C. Space Debris and Nuclear Power Source Safety

98. The effect of a collision between space debris and satellites carrying nuclear power sources (NPS) in orbit is predicted to be highly destructive. This casts some doubt on the concept of "nuclear safe orbit" which in any case does not relate easily to individual or societal risk.

99. A risk-based approach, proposed by the United Kingdom, provides a quantitative alternative basis for this class of problem. Before an additional item of debris is created, it then becomes appropriate to evaluate the risk it poses over its lifetime to the whole population of orbiting items during that time and to compare the result with the cost of alternatives. Similarly, the risk from parking an NPS in a high orbit can be, in principle, evaluated taking account of existing debris. While this approach is technically demanding, it nevertheless seems conceptually straightforward.

100. In addition, it seems necessary to require that there should be no significant interference with existing missions in space and that future missions should not be jeopardized by space pollution. It is more difficult to devise quantitative limits for the deposition of debris on extra-terrestrial bodies, whether physical, radioactive or biological. Some level of consensus judgement seems to be needed on such matters.

101. The proliferation risk from NPS in space does not seem to be negligible. If a reactor or a radioisotope generator (RTG) re-enters the atmosphere, the fissionable material is likely to reach the Earth's surface more or less intact. In the case of a reactor, approximately 100 kg of highly enriched uranium-235 may be recoverable from the impact zone, a highly significant quantity in proliferation terms. Even for RTGs, the quantities may be of some significance, since the bare critical mass for plutonium-238 is around 15 kg.

102. The major accidents at Windscale, Three Mile Island and Chernobyl emphasized that physical safety provisions are not enough. It is also necessary to take account of the people in the system who in turn respond to the organizational framework in which they are placed. The recognition of this aspect of achieving the required safety standards in terrestrial nuclear safety has led to the concept of a "safety culture:" the commitment of individuals and organizations to the overriding priority of safety. In the context of NPS in outer space, much of the safety culture provision must be at the level of the country and organizations involved in the particular mission. However, in view of the high perceived risk of transnational accidents, the top layer of safety culture needs to be at an international level.

D. Remote Sensing Applications for Sustaining Biodiversity

103. The worldwide destruction of the natural environment is reducing the number of species and the amount of genetic variations within individual species. Although 1.7 million species of plants, animals and micro-organisms have been identified and classified, the total number may exceed 30 million with the great majority living in tropical forests. More than 60,000 plant species are currently in danger of extinction because of the destruction and degradation of the Earth's vegetation. The International Union of Nature Conservation (IUNC) lists three major types of threatened species: those endangered because of near-term threats to the regenerating populations, those that are vulnerable in the long-term because populations are declining in numbers, and species that are rare because their total population is small or restricted in area. There are two principal approaches for protecting and managing nature: to ensure the population of a given species is abundant and survives and conservation of natural communities in their original habitats.

104. The International Conference on the Implementation of the World Conservation Strategy held in Ottawa in 1986 examined the experiences gained and recommended that it is important to create a very reliable database and to revise and update the ecological status of existing conservation areas to maintain their biological diversity and achieve sustainable development. Therefore, there is a need for rapid methods of

developing inventories, and performing land suitability analyses. Remote sensing has emerged as a viable technology for this purpose.

105. India has its own satellite remote sensing capability with complete space and ground infrastructure. Currently, two remote sensing satellites, IRS-1A and IRS-1B (Indian Remote Sensing Satellite), equipped with Linear Imaging Self-Scanning Sensors (LISS), provide data on the Indian subcontinent on a regular basis. The designed spectral resolution allows the identification of land cover vegetation with subtle spectral differences and enhanced mapping capabilities on large scales, i.e. 1:50,000. The new IRS-1C/D series will form the second generation of operational remote sensing system with improved features such as higher resolutions, sensing capabilities in middle infrared, stereo viewing, repeated coverage of a particular area and onboard data processing. Aerial remote sensing data can also be integrated suitably with the satellite data to obtain more detailed information of the identified "hot spots".

106. In the management of wilderness areas, it is vital to have knowledge of the habitat characteristics. Such data provides knowledge about the quality and quantity of land cover, the physical setup and human interactions. The quality of habitat is generally reflected in the status of vegetation cover and its seasonal variations. Such data, however, can only be collected by ground inventories. Remote sensing can greatly help to identify such intensive ground sampling areas. Therefore, remote sensing can contribute to forest and vegetation management programmes by:

- facilitating global and regional studies otherwise not possible with conventional methods;
- complementing regional and micro-level studies by increasing accuracy and efficiency; and
- providing integrated perspective to habitat management for biodiversity conservation.

107. Data from the NOAA's Advanced Very High Resolution Radiometer (AVHRR) provides daily information on the Earth's surface in visible and infrared regions. This data can be effectively utilized to monitor vegetation cover. The normalized difference vegetation index (NDVI) is one such ratio, which is strongly correlated with vegetation parameters such as green leaf biomass and green leaf area and hence it is of considerable value for vegetation discrimination.

108. In India, a variety of NOAA-AVHRR data was used to conduct National Agricultural Drought Assessment and Monitoring studies. The studies indicate correlation of up to four weeks with rainfall and aridity anomaly. The forest cover maps generated by visual interpretation of Landsat and NOAA data show the close similarity among closed forest, open/degraded forest and non-forest areas. A technique to evaluate potential vegetation cover using the NOAA-AVHRR generated multi-date maximum vegetation index, has also been developed in India. These maps can be of immense value in the study of vegetation, its phenology, biomass and productivity. Such data can also be used in global climatic models (GCMs) for albedo, productivity as a function of carbon sink, etc.

109. Satellite data has been extensively used to delineate forest and non-forest areas in the tropical countries where up-to-date information is lacking or inaccurate with respect to spatial distribution. The studies using visual interpretation of individual images on a scale of 1:1,000,000 or 1:250,000, carried out in India by the National Remote Sensing Agency in 1983, were the first of their kind to illustrate the potential for application of remote sensing technology at the national level. Currently, Forest Survey of India, an operational agency for such tasks, is using satellite remote sensing data to biennially map and monitor India's vegetation cover on a 1:250,000 scale. The information thus generated can be used to detect relatively undisturbed forest ecosystems, identify areas undergoing rapid changes and areas afflicted with forest density change.

110. Development of range inventory and monitoring is needed to provide direction for ecological management of grasslands. It facilitates the location of resources, determination of their quantity and extent, evaluation of their condition in relation to potential production and most importantly, allows estimation of how many animals it can support. Satellite data has been used to map grasslands and evaluate their ecological status under the Department of Space's remote sensing application programme. Two studies in alpine and semiarid bioclimatic situations have been conducted by the Indian Institute of Remote Sensing. Visual interpretation of the data has helped officials map the degradation caused primarily by erosion and overgrazing. In the alpine pasture areas of the Kinnaur district, this technique has proven useful for classifying the grassland into low level pastures and pastures dominated by grass, shrubs or mixed vegetation. The digital data has also indicated clear possibilities of mapping grassland and has shown that the middle infrared and red bands are the most useful.

111. Detailed classification of vegetation types is also an important step. Vegetation types and density classes can be directly delineated from aerial photographs or high resolution satellite imagery. The relationship between vegetation, stand type and density can be established. This is important as it constitutes a major part of wild animal forage. Such a study was been conducted in India's Kanha National Park in 1991. Density stand levels also affects mobility of wildlife and is thus important in determining sites for colonies of different flora and fauna. In particular, productivity of an ecosystem is of prime importance in habitat analysis, as it determines the food value of vegetation type.

112. There are well-defined image enhancement techniques which can greatly increase the amount of information that can be visually interpreted from the image by improving the apparent contrast between features in the scene. Spectral band rationing reduces the topographical effect by more than a factor of six on radiance data sets. Satellite digital data has been used to stratify forests based on their type, species composition and density. Although digital classification has proved to be a more accurate and objective methodology for classifying land cover features, the changes brought about by the phenological behaviour of vegetation types and illumination conditions make the methodology at times scene dependent. The former aspect can be taken into account by selecting appropriate season data when vegetation type canopies behave true to their nature.

113. Northeastern India is endowed with extremely diverse fauna, flora and people and it is among those regions of the world where shifting agriculture has been the predominant form of land use for centuries. Despite continued criticism and an effort to ban the practice, about 3 million hectares of land is currently under cultivation in this humid, tropical region. This influences the moist deciduous forest in the Himalayan foot hills and the wet evergreen forest at mid-level elevations up to the temperate habitats in eastern Himalaya in Arunachal Pradesh. Comparative analysis of vegetation maps of Chandaka Wildlife Sanctuary (Orissa), prepared by aerial photographs from 1975 and IRS satellite data from 1989, illustrate changes in the vegetation pattern and increases in the mining and agriculture areas within the sanctuary. After enforcement of the wildlife conservation act, bamboo has been found to extend into the valleys and side slopes of the sanctuary area. Thus, this technique has the potential to monitor retrogressing and successional changes in the habitat condition.

114. Acquisition of detailed stock information is a prerequisite for the development of habitat management processes. The stock maps depict forest type, density, encroachments, cultivation patches, regeneration status and provide an idea about available resources and other ecological details in the minimum management units, viz., compartments. The efforts involved for the preparation of such stock maps through conventional ground survey methods are time consuming and strenuous. Work carried out at the Space Application Centre in Ahmedabad, India, in 1989 demonstrated the uses of visual interpretation methodology to update stock maps from high resolution Salyut-7 MKF-6 multi-band photographs and IRS satellite LISS data. The information content on enlarged images (1:15,840 scale) might not be commensurate, but the available information on remote sensing data is definitely more detailed than that shown on the stock maps. E.g. the boundaries of

forest types, drainage encroachment and cultivation patches are much more reliable. Further processing through supervised classification and vegetation indexing of IRS-LISS data, overlaid with compartment boundaries, make such products extremely useful for practical field management. Recent analysis of survey requirements for habitat management indicates that stock map requirements may be accomplished only with a scale of 1:25,000.

115. Wetland areas are probably the most endangered habitats in the tropics since they are systematically reclaimed for agricultural purposes. There are two basic remote sensing approaches for monitoring wetlands: defining existing water sources and assessing water resources necessary to sustain the wildlife habitat. Aerial photographs, because of their high resolution, are excellent for identifying water holes, but temporal analysis is not cost-effective compared to satellite data. An estimate of the conservation value of the wetlands in Etawah and Mainpuri districts has been conducted at the Centre for Ornithology and Natural History in India. The major goal of the study was to determine whether the combination of satellite remote sensing and ground data would enable classification of wetlands on an ecological basis. The study focused on mapping of grasslands and three taxa viz., aquatic flora, fish and birds. Based on the spatial characteristics of the wetlands, surrounding land use, bird population diversity and density and plant community distribution, 18 wetlands areas have been identified for conservation. This study is based on geographic information system (GIS) data.

116. The natural habitats of a wide variety of species are being fragmented through development. Particularly in the forest areas managed for wildlife, there should be a network of patches of old growth forest joined by dispersed corridors of similar structure and composition. In 1990, space remote sensing data were used to collect vegetation cover information in the Corbett National Park and Rajaji National Park in India. These are important conservation areas in similar biogeographic locations. These national parks had continuous forested tracts allowing free movement of elephants in the region. However, during recent years these patches have been fragmented. The corridor which allowed free movement is used sparingly today, but in the process, elephant herds come in contact with human made land covers and conflict is often reported. Remote sensing data at various levels have helped to analyze the various land use and land cover units. The regions's socioeconomic situation is being kept in mind to restore the lost corridor. Similar applications have been reported in the Yala National Park border zone in southeastern Sri Lanka.

117. The high rate of deforestation and habitat fragmentation in tropical regions are the primary cause of the present increased rate of reduction in regional biodiversity. Remote sensing technology must play a key role in surveying, assessing the resources and recording the habitat changes. GIS technology can store, retrieve and analyze a database of collated ground level data and spatial thematic maps. The present state of the art can meet most of the habitat management requirements at various levels. Micro-level management needs, however, are only partially met from aerial photographs. The following strategies seem to be appropriate for managing forest resources in the tropics:

- Landscapes should be subdivided into manageable and meaningful regions with a variation of life zone systems. This would help in proper forest land use planning.

- Databases should be created at various levels (global, regional and at the micro-level) in a suitable format which can be accessed.

- Within each biogeographic region, pilot test sites should be selected and surveyed. Updated and more detailed inventories (from remote sensing data, if possible) can be stored in a retrieval format. There should be sites representing the entire region, sites where rapid changes are occurring (e.g. deforestation) or sites which are exceptionally productive.

- Environmental indexes from detailed ecosystem analysis should be developed in order to understand the relevant ecological properties.

- Abnormally rapid degradation should be mitigated by critical habitat management methods using available accurate and true data about existing resources.

E. Hubble Space Telescope Repair and First Scientific Results

118. The Hubble Space Telescope (HST) is a collaborative project between NASA and ESA. Based on the old concepts of an orbiting astronomical observatory, as described by Oberth as early as 1923 and by Spitzer in 1946, the HST provides astronomers access to the ultraviolet, optical and near infrared parts of the electromagnetic spectrum. When launched in 1990, after considerable delay because of the Challenger accident, the HST had a complement of five scientific instruments: two cameras, two spectrographs, and one photometer. Light is collected by a mirror 2.4 m in diameter. Within several weeks after launch it turned out that the mirror was polished to the wrong geometric shape, which resulted in images showing spherical aberration, i.e. much less than the expected amount of energy was collected in the central peak of the images.

119. HST was designed to be refurbished in orbit, as it was unlikely that all the components of this highly sophisticated space observatory would remain operational throughout the planned 15-year lifetime of the spacecraft. Thus, several of the malfunctions which occurred between 1990 and 1993, (most of them were temporarily corrected through the use of redundant components), had actually been anticipated. However, the main mirror could obviously not be exchanged in orbit. Another component, which caused serious operational problems because of thermally induced jitter, the solar panels, were in-orbit replaceable, but replacement panels had to be manufactured. It was also fortunate that even before the initial launch of HST, preparations had been made to replace the main camera on the telescope.

120. HST provided valuable information even prior to the repair mission. For example, it still provided access to the ultraviolet spectrum, retained the high resolution imaging capability, and was available in a sustained and consistent manner for synoptic investigations. However, several key capabilities were lost due to the optical flaw: the ability to detect very faint objects was lost, as was the ability to detect objects and structures near very bright sources. The ability to do accurate flux (energy) measurements was also severely impaired. These restrictions implied the loss of major science programmes, some of which had been driving reasons for building the HST: determination of the cosmological distance scale, and investigation of the physical processes in active galaxies and quasars.

121. Immediately after the optical flaw was discovered, and its nature and source had been identified, a study panel was convened by Riccardo Giacconi, then the director of the Space Telescope Science Institute. The panel brought together scientists, engineers, project managers, astronauts and industry officials. The panel sketched out a multitude of potential corrective measures, and finally recommended the implementation of a particular one: the Corrective Optics Space Telescope Axial Replacement (COSTAR). COSTAR was designed to take the place of one of the science instruments, extract an optical bench, and deploy arms carrying the corrective optics in front of the three axial instruments. This concept combined operational feasibility with minimum risk.

122. The First HST Servicing Mission was supposed to perform the following tasks: replace failed gyroscopes and drive electronics, change spent electrical fuses, replace the solar arrays, install a new wide field/planetary camera, install new magnetometers, install COSTAR, upgrade the on-board computer, install new solar array drive electronics, install a repair kit on the Goddard High Resolution Spectrograph, and finally re-boost the HST to a higher orbit. This represented a very ambitious mission profile, which the

astronauts assigned to the mission, through dedication, skill, and extended training in simulated space environments, executed with admirable success.

123. It took several weeks to transition the HST from pre-COSTAR to post-COSTAR operations. This was itself a carefully orchestrated activity designed to optimize the performance of all instruments. However, during this process it became obvious that the servicing mission had been a tremendous success. Astronomers now have available an excellent tool which is capable of answering many of the questions which modern astronomy poses.

F. Adverse Environmental Impacts on Astronomy

124. There is no doubt that the spectacular developments in science and technology since the 1950s have led to unprecedented changes in industry, commerce, communications and entertainment. Astronomers have been the beneficiaries of this technological change through enhanced sensitivity of detectors, novel telescope designs and the opportunity to not only observe from space but to fly-by the other planets of the solar system. The changes in perception of the solar system are a magnificent testament to how little was understood about planets before such missions were possible and a salutary reminder of how much remains to be understood so close to the Earth.

125. While bestowing powerful gifts upon the astronomical community, the technological age has also brought unprecedented levels of noise – weak cosmic signals are being progressively lost in a cacophony of human generated, locally transmitted signals at all electromagnetic wavelengths. Even outer space itself is being used to bombard our radiotelescopes with signals from which there can be no escape. Humanity's use of space is under threat from increasing amounts of debris left over from former missions and that debris is becoming an increasing menace to ground-based observations.

126. Radio astronomy has developed to a stage of great sophistication and sensitivity which now matches and sometimes exceeds the spatial resolution of optical astronomy. However, due to its extreme sensitivity, radio astronomy is very vulnerable. A mobile phone on the Moon would be one of the three brightest cosmic radio sources. Every piece of electrical equipment from "on/off" switches upwards is a source of radio noise. Unlike optical telescopes, radio telescopes have sidelobe responses which can pick up transmissions from sources not in the line of sight of the telescope. Powerful radio transmissions are beamed at the Earth from space and from aircraft. Fortunately, the International Telecommunications Union (ITU), which regulates the use of the frequency spectrum , has allocated 2 per cent of that spectrum (up to 275GHz) to radio astronomy. As commercial users move to higher frequencies, new allocation of frequency intervals will be made. However, at these high frequencies there are the spectral lines of interstellar molecular species. Sufficient bandwidth must be allowed for continued astronomical investigations.

127. Despite the allocation of bandwidths reserved for radio astronomy and the internationally binding nature of ITU agreements, there are daily violations of those reserved bands. Some violations arise through ignorance or disregard of ITU regulations, others occur inadvertently, e.g. re-tuning an airborne radio transmitter while in the primary beam or a sidelobe of a radio telescope. Some violations arise from inadequate standards of electronic engineering that permit leakage or drift of transmitted power into the reserved band, or through the generation of harmonic frequencies which fall into a reserved band. The GLONASS navigation satellites which use spread frequency transmissions, made observation of the important astrophysical maser line at 1612 MHz almost impossible because they utilized this frequency as their central transmitting frequency. Fortunately, this unforeseen consequence of a shared band is now in the course of resolution in the favour of astronomers through the considerable good will of GLONASS authorities. However, astronomers must look forward to 1999 before the last unmodified satellite is phased-out.

128. Like every other activity in space, space astronomy is threatened by the growing threat of space debris. It is only a matter of time before a major operational satellite is destroyed by such a collision. Debris also has other effects. The number of debris trails on deep sky astronomical plates has reached the point where 1 in 3 plates now carries one or more debris trails. Some plates are completely degraded for any scientific purpose by the sheer number of debris trails. At 7,000 pieces of trackable debris, it means that on average, there is one piece of debris every 6 square degrees of sky. A piece of debris crossing the field of view during photometric observations ruins the data and, if the trail is bright, may cause irreparable damage to sensitive detectors. The chance of a piece of debris passing through an area of sky 1 square arc second in area during standard exposure is in excess of one part in 10^{-8}, but such an unlikely event has already taken place and is documented.

129. As if the current situation with space debris is not bad enough, there have been some proposals that make the present situation look satisfactory. In recent years there have been a number of suggestions for the launch of large solar reflectors to mark particular events – e.g. the centenary of the Eiffel tower, the Olympic Games in 1996. To be seen on Earth, most of these proposals require a perceived brightness of the reflector to be that of the full Moon. Clearly, current proposals may not represent a significant threat to astronomy, but inevitable development could lead to the abandonment of any ground-based astronomy. Astronomical observation of the faintest cosmic sources at optical wavelengths can only be carried out in the "dark of the Moon", i.e. two weeks each month either side of new Moon when the Moon is in the sky for a short period just after sunset or before sunrise. To allow the sky to become populated with "artificial full Moons" would not only put an end to deep sky astronomy, but would also severely compromise many other astronomical observations. Even small solar reflectors inadvertently reflecting a beam across an unsuspecting observatory could wreak considerable havoc on sensitive instruments.

130. The astronomical community views such developments with unrelieved dismay. Solar reflectors, space debris proliferation and pressure on the radio spectrum together would mean the end of ground-based astronomy as a serious science.

131. However, the astronomical community is using all the means at its disposal to inform responsible institutions about these threats of demise of a science whose age can be measured in millennia. Fortunately, there is support for astronomical science, e.g. new outdoor lighting design is available to minimize upward light escape, the GLONASS transmission scheme is going to be redesigned. The ITU still reserves frequency bands for radio astronomy and the organizers of the 1996 Olympics in Atlanta turned down a proposal for solar reflector as a means of advertising the games. However, in the absence of firm international agreements, too much depends on local bilateral agreements and on the efforts of a few dedicated people.

G. International Cooperation in Space Research

132. Contrary to what laymen may think about the use of weightlessness in space, it allows for investigations of subtle effects of general interest, hidden on the Earth by the all-dashing impact of gravity. One of the main directions of German space research activities over the last decade has focused on the unique scientific capabilities of the European contribution to the United States Shuttle system – the Spacelab.

133. The first dedicated Spacelab D-1 mission was successfully completed in 1985. The second German Spacelab mission, D-2, was launched on 26 April 1993 on the Space Shuttle Columbia. After 10 days in orbit at about 300 km altitude, 160 revolutions around the Earth and 6.7 million flight kilometres, the D-2 mission successfully ended on 6 May 1993. Sixty-two of the 89 scientific experiments carried on the mission were developed in Germany, 7 were from France, 4 each were from Denmark and Japan, 3 were from Italy, 2 each from the Netherlands, Belgium and the United States, and 1 each from Sweden, Spain, and Switzerland.

134. The D-2 mission was a truly international mission covering all scientific topics, including: materials science (37 experiments), biology (18), human physiology (24), technology (2), Earth observation (2), astronomy (1), amateur radio (1) and even experimental sub-satellites (4).

135. Two German astronauts were selected from 1,799 applicants to fly on the mission. After a comprehensive selection process focusing on psychological, concentration, and medical tests, training commenced in March 1988 and continued for five years. Basic training included areas such as mental skills (private pilot license, jet flying on Alpha-Jet and Boeing 737 aircraft, familiarization with conditions in space (parabolic flights, scuba diving), sports, orbital mechanics, astronomy and astrophysics, general introduction into space-relevant scientific areas, scientific research on personal topics, psychological training, training in public appearances, etc. Apart from the regular astronaut training, D-2-related training included extensive introductions into all D-2 experiments, workshops, manual training of the flight experiments, training for off-nominal situations, mission simulations (both stand-alone and joint-integrated simulations with NASA), and finally NASA Shuttle training (in particular the emergency egress training) from 1 August 1992 to mission launch.

136. Brazilian space activities, as coordinated by the Brazilian National Institute for Space Research (INPE) will significantly expand in the near future. Oriented mainly to satellite communications and remote sensing, up to ten spacecraft are already planned for launches from Cape Canaveral (United States), Kourou (French Guiana), Alcantara (Brazil) and the Shanx/Talyuan complex (China).

137. The environmental data collection satellite SCD-1 (Satellite de Coleta de Dados) was successfully launched by the third Pegasus vehicle on 9 February 1993 into a low-Earth orbit with an inclination of 25° in order to provide adequate coverage of Brazil and particularly the Amazon region. SCD-2 will be ready for launch by late 1994 into a similar orbit. Two identical geostationary communication satellites Brazilsat-B1 and B2 are also scheduled for launch in 1994 by Ariane 4 launchers.

138. Based on the SCD experience, a more complex remote sensing satellite, SSR-1, equipped with a small CCD camera is being developed by INPE. It should be able to transmit 200 m resolution images in two visible spectral bands. It should be launched in 1996 with the indigenous VLS launcher from Alcantara (in the Brazilian state of Maranhao) into sun-synchronous polar orbit at 640 km altitude. An identical satellite, SSR-2 will be ready for a Brazilian launch in 1996-97. The first remote sensing satellite CBERS-1 (China-Brazil Earth Resources Satellite) developed through a cooperative Brazilian-Chinese programme, is scheduled for launch by the Long March 4A rocket in 1995-96. The optical payload of the 1,400 kg spacecraft will consist of three imaging sensors: Wide-Field imager, High-resolution CCD Camera (producing 20 m resolution images) and Infrared Multispectral Scanner. It will also carry a data collection system. CBERS-2, fully integrated in Brazil, will be ready for placement into orbit by a Chinese launcher in 1998-99.

139. In the field of small scientific satellites, Brazil is actively cooperating with Argentina in preparation of SAC-B (Scientific Argentinean Satellite). The satellite and its components are being tested at INPE's integration and test laboratory which is also available for industrial applications. A solar astronomy spacecraft is being developed jointly with Italy and the United States. It will monitor solar eruptions, high energy X-rays and gamma ray bursts. The satellite is scheduled for launch on a Pegasus rocket in June 1995.

140. Space research activities have continued in the former Czechoslovakia where small scientific satellites weighing about 50 kg have been developed for the Magnetosphere-Ionosphere (MAGION) research programme. The first MAGION satellite (weighing only 15 kg) was launched on 24 October 1978 to make simultaneous measurements with Intercosmos-18. Two more sophisticated satellites were launched into high-inclination and low-eccentricity orbits (altitude 500-3200 km) as a part of the mother-daughter active space experiment missions: ACTIVE (MAGION-2, launched on 28 September 1989) and APEX (MAGION-3, launched on 18 December 1991). The payload of the subsatellites was used as an independent diagnostic

package. During the periods when no active experiments were switched on, the satellites and subsatellites were used for simultaneous two-point measurement of natural phenomena.

141. Two other MAGION-type subsatellites of similar mechanical design and electrical subsystems have been designed for the INTERBALL mission aimed at studying physical mechanisms of solar wind energy accumulation in the magnetosphere and dissipation of the energy in the auroral regions during magnetic substorms.

142. The INTERBALL mission consists of two pairs of spacecraft, situated in different orbits. On pair, the "Auroral Probe" with an apogee of about 20,000 km; the other one, the "Tail Probe", with an apogee of 200,000 km. Both orbits should have perigee heights of about 500 km and inclinations of 65°. Each pair of satellites consists of the main spacecraft of the PROGNOZ series, accompanied by a subsatellite of the MAGION type. The scientific objectives for the subsatellites are to separate time and space variations, to study spatial correlations and fine structures in the ionosphere and magnetosphere. Separation of the subsatellites will be controlled by small thrusters. The scientific payload of the subsatellites includes instruments for measurement of magnetic and electric fields, plasma waves, cold and hot plasmas and energetic particles. The INTERBALL subsatellite payload and subsystems have been developed and manufactured through an international cooperative effort involving Austria, the Czech Republic, France, Germany, Poland, Slovakia, Romania and the Russian Federation.

143. During the last few years, there has been a trend to concentrating the types of satellite orbits used for practical purposes into two separate categories: the distant GSO and the closer LEO. Despite the difference in the distance, satellite users need increased positional accuracy to accomplish their intended mission. Surprisingly, this turned out to be easier in the case of the distant GSO than in LEO. The reason is that perturbing forces affecting the motion of the satellite are much better defined for GSO than for LEO. One of the most disturbing and unstable forces is atmospheric drag and lift.

144. To develop a good model of satellite motion in the upper atmosphere, one must first have precise experimental data about atmospheric parameters and their spatial and temporal changes. An instrument which can measure all disturbing forces of non-gravitational origin (including atmospheric drag and lift) acting on a satellite is called an accelerometer, or a microaccelerometer if it is extremely sensitive. In principle, it measures a relative motion of two objects on the same orbit, i.e. the centres of mass of both orbits move on the same space trajectory, whereas one body is subjected to the atmospheric acceleration and the other one is shielded from that effect. In practice, an accelerometer consists of a proof-mass (a small ball or cube) located inside a cavity and the change of the distance of a proof-mass from external body is precisely measured. Preferably, this instrument should be situated in the center of the mass of the satellite to eliminate other effects.

145. Such types of accelerometers, capable of measuring acceleration of the order of 10^{-5} to 10^{-10} $m.s^{-2}$ have already been constructed and some of them have even been placed into orbit (French Cactus, Supercactus, Gradio). At the Astronomical Institute of the Czech Academy of Sciences, an accelerometer with a cubic proof-mass is now under development. The device is called "Macek" and was tested in orbit in June 1992 on board the recoverable Resource-F satellite. The Russian capsule returned softly to the Earth, and the mechanical condition of the instrument was checked. During this technological experiment, practical information about the reliability of the construction was obtained with very encouraging and promising results. The main drawback of this experiment was an inconvenient location of the microaccelerometer on the main satellite body. Therefore, centrifugal force due to satellite rotation caused profound disturbances which "masked" most of the atmospheric effects.

146. The ultimate goal is to place the Macek accelerometer on a dedicated satellite where it will be possible to get precise data on the atmospheric density distribution and variation. The vehicle for achieving this goal

is the Central European Satellite for Advanced Research (CESAR) project, undertaken through a cooperative programme among Austria, the Czech Republic, Hungary, Italy and Poland. The project is now in the final stage of its Phase A with agreed details of instrumentation, telemetric systems and orbit selection. The launch of this satellite for the study of the physical properties of the near-Earth environment is now scheduled for 1997.

Appendix

LIST OF SCIENTIFIC AND TECHNICAL PRESENTATIONS

I. SYMPOSIUM ON SPACE APPLICATIONS FOR DISASTER PREVENTION, WARNING, MITIGATION AND RELIEF, ORGANIZED BY COSPAR AND IAF

The Symposium was co-chaired by Mr. L. M. G. Enomoto, representing IAF and Mr. S. Bauer, representing COSPAR (first session) and Mr. A. Azcarraga, President of the IAF and Mr. H. Stoewer, representing COSPAR (second session). Mr. R. Gibson of the IAF was the Rapporteur for both sessions of the symposium.

"Space Contributions," Mr. L. Emiliani, Director, Observation of the Earth and its Environment, European Space Agency.

"Space Observations for Understanding (and Predicting?) Earthquakes and Volcanic Eruptions," Mr. J.L. Le Mouël, Director, L'Institut de Physique du Globe de Paris, France.

"Remote Sensing of Severe Weather Events," Mr. W. P. Menzel, Space Science and Engineering Center, University of Wisconsin, United States.

"Desertification and Land Degradation," Mr. Zheng Du, Director, Institute of Geography, Chinese Academy of Sciences, China.

"Floods and Droughts," Mr. U. R. Rao, Chairman, Indian Space Research Organization, India.

"Global Food Security," Mr. F. L. Snijders, Remote Sensing Centre, Food and Agriculture Organization of the United Nations.

"GEOWARN," Mr. E. Slachmuylders, ISU/ESA-ESTEC, and Mr. W. Neubert, Technische Universität, Vienna, Austria.

"Summary of the Symposium," Mr. R. Gibson, International Astronautical Federation.

II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

"Hubble Space Telescope Servicing Mission and First Scientific Results," Mr. K. Bowersox, Astronaut, NASA, United States, and Mr. R. Albrecht, European Southern Observatory, European Space Agency.

"Remote Sensing Applications for Sustaining Bio-diversity," Mr. M. G. Chandrasekhar, Indian Space Research Organization, India.

"Brazil in Space," Mr. R. da Cunha, Instituto Nacional de Pesquisas Espaciais, Brazil.

"Use of Nuclear Power Sources in Space," Mr. B. Wade, Atomic Energy Agency, United Kingdom.

"A Review of Scientific and Technical Aspects of Space Debris," Mr. D. Rex, Technical University of Braunschweig, Germany.

"Orbital Debris,", Mr. J. P. Loftus, Jr., NASA, United States.

"Space Debris Research in India," Mr. K. Sridharamurthi, India.

"CNES and Space Debris Issue," Mr. H. Laporte-Weywada, Directorate of Launchers, Centre National d'Etudes Spatiales, France.

"Space Debris - Research in ESA," Mr. W. Flury, ESOC, European Space Agency.

"Space Debris - United Kingdom Position," Mr. R. Crowther, Defence Research Agency, Farnborough, United Kingdom.

"Flight of Spacelab D-2," Mr. U. Walter, Astronaut, German Aerospace Research Establishment DRL, Germany.

"Remote Sensing and SPOT Image," Mr. C. Jung, SPOT Image, France.

"Experiment MACEK as a Part of the Project CESAR," Mr. L. Sehnal, Astronomical Institute, Czech Academy of Sciences, Czech Republic.

"INTERBALL Subsatellites", Mr. P. Třiska, Geophysical Institute, Czech Academy of Sciences, Czech Republic.

"Adverse Environmental Impacts on Astronomy," Mr. D. McNally, International Astronomical Union.

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COMMITTEE ON THE PEACEFUL
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Vienna, 6-17 June 1994

MATTERS RELATED TO THE POSSIBLE HOLDING OF A THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

Report by the Secretariat

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INTRODUCTION

1. The General Assembly, in paragraph 20 of its resolution 47/67 of 14 December 1992, recommended that Member States might discuss, during the next sessions of the Committee on the Peaceful Uses of Outer Space, the possibility of holding a third United Nations conference on the exploration and peaceful uses of outer space (a third UNISPACE conference).

2. Pursuant to that recommendation and similar recommendations emanating from the Scientific and Technical Subcommittee at its thirtieth session (A/AC.105/543, para. 98 and annex II, para. 20), the Committee at its thirty-sixth session, in 1993, considered in general terms the question of holding such a conference, including the goals and objectives of such a conference, as well as matters related to organization, venue, timing, and funding implications. The Committee requested the Scientific and Technical Subcommittee to further discuss matters at its thirty-first session, in 1994, with a view to promoting an early conclusion on the matter by the Committee. 1/

3. The General Assembly, in paragraphs 22 and 23 of its resolution 48/39 of 10 December 1993, with a view to promoting an early conclusion on the matter by the Committee, requested the Scientific and Technical Subcommittee to continue its discussions on the matter and agreed that the most important step was to define a set of sharply focused objectives for such a conference and that details such as organization, venue, timing and funding should also be considered. In paragraph 24 of the same resolution, the Assembly noted that the goals set for such a conference might be achieved by other means, including intensification of work within the Committee.

4. Pursuant to that resolution, the Scientific and Technical Subcommittee at its thirty-first session, in 1994, continued its discussions of the possibility of holding a third UNISPACE conference. Working papers on various matters related to the holding of such a conference were submitted by India (A/AC.105/C.1/L.195), Pakistan (A/AC.105/C.1/L.191) and by the States members of the Group of 77 (A/AC.105/C.1/L.199). The latter working paper represented an amalgamation and expansion of the views contained in the Indian and Pakistan working papers. At that session the Government of India reiterated its offer, originally made at the thirty-sixth session of the Committee, in 1993, to host a third UNISPACE conference at its Space Centre at Bangalore.

5. The Subcommittee agreed that the Committee should further consider the ideas and proposals on the matter, as well as any others that might be submitted at a later date (A/AC.105/571, para. 112). To further discussions on the matter within the Committee, the Subcommittee requested the Secretariat to prepare, in time for the thirty-seventh session of the Committee, "a comprehensive report on the likely organization, funding and logistical implications of holding such a conference. The report should include an analysis of UNISPACE 82,* including its organization, funding and logistics, as well as an analysis of various combinations of duration, scope and venue (including both United Nations headquarters cities and other sites) for a third UNISPACE conference" (A/AC.105/571, para. 113).

I. SCOPE OF THE PRESENT REPORT

6. The present report is divided into three parts: the first part (section II) reviews the discussions on the possibility of holding a third UNISPACE conference that have taken place thus far in the Committee and the Scientific and Technical Subcommittee in the context of changes that have taken place since UNISPACE 82;

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*Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, held at Vienna from 9 to 21 August 1982.

the second part (section III) is an analysis of UNISPACE 82 in the context outlined in paragraph 5 above; and the third part (section IV) provides an analysis of these issues in the context of holding a third UNISPACE conference.

7. The objectives, scope and agenda of a third UNISPACE conference would be decided by the General Assembly, based on the recommendations of the Committee.

8. Sections III and IV utilize figures provided by the Office of Financial Services of the United Nations Secretariat. The figures in section III represent the most recent estimates provided by the Office of Financial Services of the Secretariat.

9. In considering possible venues for a third UNISPACE conference, the present report by the Secretariat, prepared pursuant to the request of the Subcommittee at its thirty-first session (A/AC.105/571, para. 113), deals with only four cities: Bangalore, India; Geneva; New York; and Vienna. Bangalore is included because the Government of India has made a formal offer to act as host to the proposed conference. Costs for other locations, should other Governments offer to host the proposed conference, would be similar to those cited for Bangalore though they would differ to the extent that travel and daily subsistence allowance costs vary depending on the location. In keeping with past practice of the Committee, and in accordance with the agreement reached in the Scientific and Technical Subcommittee (A/AC.105/571, para. 114), the venue of the proposed conference would be decided by consensus.

II. THE CHANGING CONTEXT OF INTERNATIONAL SPACE ACTIVITIES AND POSSIBLE RATIONALE FOR CONVENING A THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

10. The primary objective of UNISPACE 82 was "to adopt effective means for using satellite programmes to assist in the solution of problems of regional or global significance and to strengthen the capabilities of Member States, in particular developing countries, to use the applications of space research for their own economic and social development" (A/AC.105/179, para. 21).

11. To support that objective, it was noted that the applications of space technology had increased dramatically since 1968, when the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space had been held, that there was an urgent need to ensure adequate transfer of technology so that all countries could reap the benefits of those applications, and that there was a need to bring to the attention of developing countries, at the highest levels, specific applications of space technology in areas such as agriculture, efficient utilization of natural resources, land and water management, disaster warning and prevention, and environmental monitoring.

12. As described below, and as has been suggested in discussions in the Committee and the Scientific and Technical Subcommittee, that rationale remains valid today and could serve as objectives of a third UNISPACE conference.

13. The suggestion has also been made that although sufficient rationale for holding a third UNISPACE conference exists, it is not necessary to hold a conference as the objectives could be achieved by other means, including intensification of work within the Committee.

14. Much has changed since 1982, however, in the international political situation and, in particular, in space technology and its applications and in the space activities of Member States. Those dramatic changes are viewed as justification for considering the possibility of holding a third UNISPACE conference.

15. The most significant change to have occurred since the convening of UNISPACE 82 has been the end of the cold war. As analysis of the UNISPACE 82 experience shows, that conference was severely constrained, in its planning, in its work and in its results, by the East-West and North-South tensions that characterized international relations at that time. The new, generally cooperative and non-belligerent tone that currently characterizes international relations would increase the likelihood that a third UNISPACE conference would be more meaningful and would be able to make substantive progress on whatever items were included in its agenda.

16. The ways in which Member States approach space activities have also changed dramatically in the 12 years since the convening of UNISPACE 82. For the most part, space activities conducted prior to 1982, and to a certain extent until only recently, were primarily conducted by Governments pursuing national objectives. While there was a significant amount of bilateral cooperation in space activities, in a general sense, international cooperation, when pursued, was often conducted in conjunction with political and ideological goals.

17. This has changed over the past decade, with the most rapid and significant changes occurring in the past several years. To some extent, credit must be given to UNISPACE 82 for the acceleration in international cooperation and the expansion of access by developing countries to space technology and applications that have occurred since that conference was held. Equally important has been the development of significant space capabilities by some developing countries, which has not only set an example for other countries, but has also expanded the opportunities for cooperation among developing countries themselves. The end of the cold war has also led to the initiation of significant levels of cooperation in space activities among the major space powers that had previously been unimaginable. The net effect of those developments, evident in the spirit of cooperation and consensus that has prevailed at recent sessions of the Committee, has been an increased transparency in international space activities and an increased willingness on the part of Member States, both developed and developing countries, to cooperate in space activities.

18. The expansion of international cooperation in space activities was evident in the celebration in 1992 of International Space Year. As part of the organization and planning process for the Year, 29 national space agencies and organizations from both developed and developing countries participated in the Space Agency Forum for International Space Year. The Forum was responsible for a variety of projects based on the theme "Mission to planet Earth," all of which were conducted on a cooperative basis. Because of the success of that broad cooperative effort, the members of the Forum have decided to continue many of the projects started for International Space Year and are exploring further possibilities of how to make the benefits of "Mission to planet Earth" projects more available to developing countries.

19. While it is making admirable efforts to consider the needs of developing countries, the Forum is comprised primarily of agencies and organizations from countries with significant space capabilities and there remains a need to involve agencies and organizations from countries without such capabilities in the activities of the Forum. A necessary step towards achieving that goal would be to match existing space capabilities with current demands in developing countries. Such a process might be facilitated by a third UNISPACE conference.

20. Today, there is significantly more awareness of the potential of space technology for improving life on Earth, and more widespread use of space technology, than in 1982. Since the convening of UNISPACE 82, many more countries have become active participants in space activities, through the development of indigenous launchers and satellites as well as through the acquisition and use of space technology through various cooperative efforts. Virtually every country in the world now uses satellites for communications, meteorology, television and radio broadcasting and other applications that materially improve the lives of its citizens. The use of remote-sensing data for applications such as agriculture, resource management and environmental monitoring at the national level and, to some extent, at the regional level has also become

more common. The diffusion of space technology into many areas of everyday life has been accompanied, and indeed fostered, by the rapid commercialization of space technology and services, particularly in the fields of communications, broadcasting and remote sensing.

21. Similarly, there is increasing awareness of the value of space technology in providing solutions to problems that transcend narrow national interests. The United Nations Conference on Environment and Development, held at Rio de Janeiro, Brazil, from 3 to 14 June 1992, highlighted the significant environmental problems faced by all countries, as well as the link between environmental protection and sustainable development of the world's resources. In adopting Agenda 21, 2/ the Conference recognized the important contribution that space technology could make to environmental monitoring and sustainable development, particularly in the areas of land-use planning and management, deforestation, desertification, water resource assessment and the scientific study of environmental dynamics. In many other areas, Agenda 21 called for expanded and improved environmental monitoring, data collection and resource survey activities in which space technology could play an important role.

22. In response to requests from the Committee and the Scientific and Technical Subcommittee, detailed analyses of the applications of space technology to Agenda 21 were prepared by the Office for Outer Space Affairs in 1993 (A/AC.105/547 and Add.1). Those documents may be useful to the Committee in its consideration of matters related to the holding of a third UNISPACE conference.

23. Another important trend has developed, in parallel to those mentioned above, that has had an equally significant impact on international space activities. It primarily involves the financial aspects of space technology. While space technology and space applications have expanded rapidly over the past decade, so too has the cost of conducting space activities. Coupled with global economic difficulties and the removal of the political-prestige impetus that drove many space activities during the cold war, the rising cost of space activities has had two important results. It has caused many countries to re-evaluate their efforts to acquire space-related technology and infrastructure, and it has encouraged States to increasingly pursue international cooperation in conducting space activities.

24. These changes have also greatly affected the basis of the national space programmes of the space powers. Because these programmes are no longer primarily politically motivated and because resources have become increasingly scarce, there is an increasing need to explain the benefits of space technology to the general public and to justify requests for funding with tangible proof of the value of those programmes.

25. The United Nations itself has not been immune to financial difficulties. Faced with broadening responsibilities for its services in peace-keeping and related fields, the United Nations is experiencing a financial crisis that has severely limited the funding available for existing programmes and that has largely precluded the creation of new programmes. This fact must be borne in mind by Member States in developing the agenda of a third UNISPACE conference and in formulating possible recommendations for such a conference. During the planning phase of such a conference, it would therefore be necessary to develop creative ways to finance the implementation of any recommendations that such a conference might make, to the extent feasible, utilizing existing funding sources.

26. Despite the financial constraints facing it, the United Nations, as well as the entire international community, is confronted with numerous post-cold-war challenges related to space technology and its applications, including the need to shift resources once dedicated to military uses towards more productive purposes, the commercialization of space technology, and the need to develop ways to monitor and protect the environment. The boundary between military and civilian space systems that existed during the cold war is becoming increasingly blurred. This has allowed some advanced military space technologies to be used for productive civilian purposes and at the same time has also raised concerns about the spread of these

technologies and the implications that they would have on the proliferation of weapons of mass destruction. Another factor that must be considered is the need to ensure the safety of future space activities.

27. The new security environment faced by the international community and the challenges it presents to the United Nations was outlined by the Secretary-General in his report entitled "An agenda for peace" (A/47/277). As a follow-up to that report, the Secretary-General issued a report in 1993 entitled "International cooperation in space activities for enhancing security in the post-cold war era" (A/48/221). In that report the Secretary-General outlined ways in which space technology could be utilized by the international community to promote security in all its forms - economic, political, military and environmental - and suggested new approaches that could be pursued with regard to utilizing space technology for that purpose. He also outlined specific measures that could be taken by Member States and the United Nations itself to develop confidence-building measures for outer space activities and to improve access to space technology.

28. Taken together, the changed international political situation, advances in space technology and in its applications and increased awareness of their potential terrestrial benefits, the recognition of the special role that space technology can play in areas of universal concern, such as the environment and disaster warning, mitigation and relief, and the potential role of space technology in enhancing international peace and security should provide ample basis for the Committee to develop a set of sharply focused objectives for a third UNISPACE conference, in accordance with General Assembly resolution 48/39.

29. The objectives could include a review of the developments in space activities since 1982, including advances in space technology, new economic and social applications, and economic factors limiting the development of space technology and its applications. On the basis of that review, a third UNISPACE conference could consider how States could make the best use of existing systems and opportunities and how international cooperation could be strengthened to provide new systems, applications and further opportunities for international cooperation. In particular, a third UNISPACE conference might consider how international cooperation in the field of remote sensing, weather and climate observations and environmental monitoring could be strengthened to promote the use of such systems by all States and to ensure adequate financial resources to maintain and improve those systems.

30. Additionally, such a conference would be a valuable forum in which to address the concerns of many States regarding the need to ensure continuity in space systems, particularly those related to meteorology and remote sensing. Only if such continuity is ensured will Governments and the private sector invest in ground infrastructure, such as data reception and processing facilities, which are necessary to make full use of such systems. Many Governments have also expressed concern in the Committee regarding the need to ensure that all States have access to the data from space systems on reasonable terms. A third UNISPACE conference would be an appropriate forum in which to evaluate various alternatives that have been proposed for ensuring such access.

31. There is also a pressing need to ensure that all States can, in practice as well as in principle, use data from space systems, which requires the development of indigenous capabilities in all States. A third UNISPACE conference could address the various issues related to education, training and technical assistance in space science and technology and their applications. There is also a need to analyse the relationship between commercialization of space technology and the development of indigenous capabilities with a view to making developing countries equal partners in the development and utilization of those technologies.

32. While the States that are most active in space are members of the Committee on the Peaceful Uses of Outer Space, the 131 Member States that are not members of the Committee are also users of space technology. A third UNISPACE conference would provide those States with the opportunity to participate fully in United Nations discussions on international space policy. It would thus provide the members of the

Committee with an opportunity to exchange information on space activities, policies, priorities and needs with those States and would encourage broader use of space applications and participation in space activities.

33. The working papers containing additional analysis and proposals on the objectives, venue, funding and organization of the proposed third UNISPACE conference, referred to in paragraph 4 above, could constitute a basis for future discussions on the matter within the Committee and the Subcommittee.

III. ANALYSIS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

A. Organization and logistics

Initial discussions and preparatory phase

34. Discussions on the possibility of convening a second UNISPACE conference began in the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee in 1974. The same year, at the request of the Committee, a questionnaire was sent by the Secretary-General of the United Nations to all Member States to solicit their views on the matter. In 1976, the Scientific and Technical Subcommittee established an informal working group to consider various proposals regarding the convening of such a conference. The Secretariat was asked to prepare an in-depth study on matters related to the proposed conference. Additional information was requested from Member States in 1977.

35. On the recommendation of the Committee, the General Assembly adopted resolution 33/16 of 10 November 1978. In that resolution, the Assembly adopted the recommendations of the Committee on convening a second UNISPACE conference and on designating the Committee on the Peaceful Uses of Outer Space as the Preparatory Committee for the Conference and the Scientific and Technical Subcommittee as the Advisory Committee to the Preparatory Committee.

36. The Committee, in its capacity as Preparatory Committee for the Conference, held four sessions and the Advisory Committee held three. At its first session, in 1979, the Preparatory Committee recommended that the conference be held in the second half of 1982. At the same session, the Preparatory Committee, taking into account the recommendations of the Scientific and Technical Subcommittee and the views of Member States expressed in their replies to the questionnaire referred to in paragraph 34 above, made detailed recommendations to the General Assembly regarding the title, basic objectives, provisional agenda, final report, preparation and organization of the conference and proposed a ceiling for its cost. The General Assembly endorsed those recommendations in its resolution 34/67 of 5 December 1979.

37. The second session of the Preparatory Committee was held in 1980. It approved plans for the preparation of background papers suggested by the Outer Space Affairs Division (now the Office for Outer Space Affairs of the Secretariat), recommended that the conference be of two weeks' duration and made detailed recommendations regarding participants in the conference and public information activities. The latter included, inter alia, the issuance by the United Nations Postal Administration of a special stamp commemorating the exploration and peaceful uses of outer space, the organization of essay and poster contests, the provision of exhibition space at United Nations Headquarters for Member States to display space-related items and information, and the publication of a pre-conference booklet, and a periodic newsletter. After considering offers to host the conference from the Governments of Austria and the former Union of Soviet Socialist Republics, the Committee recommended that the conference be held at Vienna. Those recommendations were endorsed by the General Assembly in its resolution 35/15 of 3 November 1980.

Secretariat of the Conference

38. Establishment of the UNISPACE 82 secretariat became linked to the sensitive political situation that existed at that time and a situation arose in which it was necessary for the highest posts of the secretariat to be geographically and politically balanced. As a result, the secretariat of the Conference included, in addition to the Secretary-General of the Conference, three deputy secretaries-general and three assistant secretaries-general appointed from outside the United Nations. That arrangement resulted in top-heavy management for the Conference and provided little substantive benefit and, because those officials performed a minimal amount of conference-related tasks, the bulk of the work was carried out by the Secretary-General of the Conference, the Executive Secretary and the secretariat. The arrangement also had financial impact on the Conference as the posts of the deputy and assistant secretaries-general had not been included in the original budget and had to be financed out of funds intended for consultants.

39. The Executive Secretary was assigned from the Outer Space Affairs Division. The secretariat staff consisted of a special assistant to the Secretary-General of the Conference, a technical writer/editor and a public information specialist, all at the P-3, P-4 or P-5 level. Three General Service staff members also served as part of the secretariat. Most of those staff members were current or former members of the Outer Space Affairs Division or of other relevant United Nations entities. Other staff of the Outer Space Affairs Division assisted the secretariat staff during the Conference itself and the Division also provided secretaries to the technical committees of the Conference. UNISPACE 82 illustrated the importance of having as members of the secretariat staff members from the Outer Space Affairs Division who were familiar with the technical issues involved, with their political implications, and with the United Nations system and procedures. The fact that those persons also returned to the Outer Space Affairs Division after the Conference ensured effective implementation of follow-up activities.

40. Consultants were used to assist in the preparation of technical background papers, in the regional seminars and in other technical preparatory activities. The consultants were funded partly from the conference budget and partly through contributions from Governments and specialized international organizations.

41. The Secretary-General of the Conference was appointed in October 1980 and took office in March 1981, at which time the secretariat was formally established in New York. The Outer Space Affairs Division, however, had begun preliminary preparatory work several months earlier. Due to political difficulties, the deputy and assistant secretaries-general were not appointed until December 1981.

Preparation of the report

42. The secretariat began preparation of a preliminary version of the draft report of the Conference in 1981, taking into account national papers that had been submitted. The preliminary version of the draft report was discussed by the Advisory Committee in January 1982. The background papers prepared by the Secretariat, including one on expanding the mandate of the United Nations Programme on Space Applications, also provided valuable input for the substantive part of the draft report. The preliminary version of the draft report was then revised by the secretariat, further revised by the Preparatory Committee in March 1982 and circulated to all States 90 days prior to the Conference. The procedure followed for the preparation of the draft report allowed ample time for States to review it, for the preparatory committees to discuss and revise it, and for the Secretary-General of the Conference to conduct the necessary consultations with States on it and on other matters related to the organization of the Conference.

Other activities related to the Conference

43. Concurrently, the secretariat of the Conference undertook a variety of pre-Conference activities that focused on both the substantive preparations for the Conference and public information activities.

44. Under the auspices of the United Nations Programme on Space Applications, a number of pre-Conference regional meetings and seminars were held in 1981 and 1982, at Addis Ababa, at Buenos Aires, at Jakarta, at Quito and at Toulouse, France. The seminars helped to focus international attention on the Conference and provided input for the national papers submitted to the Preparatory Committee and the Conference. They also served to inform potential Conference participants about the issues to be discussed. The secretariat enlisted the support of various intergovernmental and non-governmental organizations in organizing special meetings related to the themes of UNISPACE 82. The meetings made substantial contributions to the overall preparatory process. The United Nations Programme on Space Applications also organized three follow-up conferences for Member States, focusing on the results of UNISPACE 82.

45. In addition to the wide variety of public information and public awareness activities organized by the secretariat of the Conference, significant effort was made to create press, radio and television publicity and several lectures were organized at various forums to raise the profile of the Conference. Those activities were essential in increasing public interest in outer space in general and in the Conference. Three books related to the Conference were published following the convening of UNISPACE 82: one contained the background papers prepared by the Secretariat, one contained the national papers submitted to the Secretariat and one contained a review of a pre-Conference round-table. The publications helped to further publicize the Conference and its results.

Host country agreement

46. Discussions with the Government of Austria, the host country, regarding the practical and legal arrangements for the Conference began soon after the venue was decided by the General Assembly in its resolution 35/15. Negotiations on the host country agreement were completed in January 1982 but still required approval by various authorities within Austria, including its legislative bodies, so that the actual agreement was not signed until May 1982. That was preceded by a series of meetings between the secretariat of the Conference and Austrian officials that proved vital for liaison and communication. UNISPACE 82 highlighted the need for early discussions and negotiations on the host country agreement and on practical conference arrangements, including meeting facilities, security, associated activities, and accommodations.

Organization of the Conference

47. The Conference itself was organized into a plenary and three committees, each dealing with a particular aspect of the agenda. There was a provision that not more than two meetings would be held simultaneously. The three committees were as follows: State of Space Science and Technology; Applications of Space Science and Technology; and International Cooperation and the Role of the United Nations. A credentials committee was also convened by the plenary. Following the first two days of plenary meetings, the plenary continued its general debate for three days, in parallel with one committee meeting. The other two committees then held parallel meetings for three days. Finally, the plenary was reconvened for the two days to adopt the report of the Conference.

48. The bureau of the Conference, elected at the 1st meeting of the plenary, consisted of representatives of 17 States who served as vice-presidents, a rapporteur-general, chairmen and vice-chairmen of the committees. Those positions were allotted to ensure a reasonable regional balance. An informal group called "Friends of the President" was organized from among the members of the bureau to assist the President (the Austrian Foreign Minister) in the final negotiations on the report of the Conference.

B. Funding

49. As part of the initial preparations for UNISPACE 82, the Secretariat of the United Nations prepared for the Advisory Committee a study on the financial implications of such a conference (A/AC.105/L.108 and Add.1 and Corr.1 and 2 and Add.2 and 3). The estimates contained in that study were updated for the General Assembly in 1979 (A/C.5/34/45). The latter study estimated the cost of holding a two-week conference at United Nations Headquarters in New York to be $2.05 million (1980-1982 dollars), which included $625,000 in conference-servicing costs.*

50. In addition to the amount provided through the United Nations budget, it should be noted that Austria, as the host country, was responsible for paying the incremental costs related to having the Conference at Vienna rather than in New York, the headquarters of the relevant secretariat at the time of the Conference. As included in the host country agreement, those costs were estimated to be approximately $480,000, which covered, inter alia, incremental secretariat, conference-servicing, daily subsistence allowance, travel and freight costs.

51. Several of the pre-conference activities, in particular some of the regional seminars, were made possible by voluntary contributions by some Governments for that purpose. Funding for public information activities ($50,000) was also supplemented by financial and in-kind contributions from other international and non-governmental organizations.

IV. POSSIBLE ORGANIZATION OF A THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

A. Organization and logistics

Initial discussions and preparatory phase

52. As noted in paragraphs 1-4 of the present report, the possibility of convening a third UNISPACE conference has been discussed in the Committee on the Peaceful Uses of Outer Space and its Scientific and Technical Subcommittee since 1993.

53. It would be possible to follow an organizational plan similar to the one followed for UNISPACE 82. In that case, upon approval by the General Assembly, the Committee on the Peaceful Uses of Outer Space could serve as the preparatory committee for the proposed third UNISPACE conference and the Scientific and Technical Subcommittee could serve as advisory committee to the preparatory committee (hereafter both are referred to as the preparatory committee). That would involve minimal cost but would also require some modification of the work programmes of the preparatory committees on other areas during the preparatory process.

54. As the preparatory committee, the Committee on the Peaceful Uses of Outer Space would be required to make detailed recommendations to the General Assembly on the objectives, agenda, organization, venue and cost and funding of the proposed third UNISPACE conference, as well as the nature of the final

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*According to information provided by the Financial Service of the United Nations Office at Vienna, the inflation rate in Austria for the period 1982-1993 was approximately 3.3 per cent per year (or 39.3 per cent for the entire period). That figure can be used as a rough estimate of global inflation rates during that period.

document(s) to be adopted by the conference, which could include one or more of the following: the report of the conference, the declaration, the plan of action.

55. The preparatory committee would also be responsible for developing provisional rules of procedure for the conference. Such rules would cover, inter alia, the decision-making process (consensus), procedures for election and appointment of the bureau, and procedures for the work of the conference committees.

Preparation of the report

56. The most important function of the preparatory committee would be to consider and agree on a draft of the conference document(s). As with UNISPACE 82, it would be necessary to begin preparation of the draft report of the proposed third UNISPACE conference at least one year prior to the convening of the conference and to conduct extensive consultations with Member States and, whenever appropriate, to seek the widest possible input on the content of the draft report from Member States. The conference secretariat would prepare the initial draft(s) on the basis of the guidelines provided by the preparatory committee. The preparatory committee, working in conjunction with the conference secretariat, other United Nations entities and international organizations, would be responsible for the preparation of the draft report.

57. A small number of analytical background papers would be prepared by the conference secretariat, within the existing resources of the ongoing publication programme of the Office for Outer Space Affairs, which would be focused on conference-related matters for the preparatory period, to provide all Member States with essential technical information on the issues to be addressed by the conference. National papers could be prepared and submitted by Member States to the preparatory committee and the conference but would be circulated in the quantity and form submitted, without processing or reproduction by the secretariat. That procedure, which has been followed by other recent United Nations conferences, would significantly reduce the cost of documentation compared with that of UNISPACE 82. The major focus of the preparation of pre-conference documents would therefore be on the declaration, the plan of action and the report of the conference, which would ultimately be adopted by the conference.

58. Preparation of the analytical background documents by the conference secretariat, which would be the first step in the preparatory process, should begin as soon as possible. Making decisions on the number and the topics of such documents would require input by the preparatory committee and would logically require the prior approval of a draft provisional agenda for the conference.

Secretariat of the conference

59. The Office for Outer Space Affairs could serve as the substantive secretariat of a third UNISPACE conference and could provide the executive secretary of the conference. It would also be necessary to appoint, on a temporary basis for about 12 months prior to the conference, one or two technical writers or editors and to allow for the hiring of short-term consultants as needed to assist in the preparation of conference-related material on which there is no in-house expertise. Because its staff has been augmented since UNISPACE 82 and has the experience of that Conference behind it, the Office for Outer Space Affairs, together with the minimum additional support described above, should be able to meet the demands that would be placed on it should it be designated as the secretariat for a third UNISPACE conference.

60. In the past, it was usual for the Secretary-General of the United Nations to appoint a secretary-general for a major United Nations conference. More recently, most United Nations conferences have been coordinated by a senior staff member of the Secretariat of the United Nations. Examples of such conferences include the World Conference on Natural Disaster Reduction, to be held at Yokohama, Japan, from 23 to 27 May 1994, the United Nations Global Conference on the Sustainable Development of Small Island Developing States, held in Barbados in April 1994, the International Conference on Population and

Development, to be held at Cairo from 5 to 13 September 1994, and the World Summit for Social Development, to be held at Copenhagen in March 1995. With the exception of the United Nations Conference on Environment and Development, which had an unpaid Secretary-General and one Deputy Secretary-General, no recent United Nations conferences have had deputy secretaries-general or special senior advisers appointed from outside the United Nations.

61. Should a secretary-general of the conference be appointed, the cost to the United Nations could be minimized by limiting the time in which the individual serves on a full-time basis at the location of the secretariat and/or by having an interested Government provide such an individual at no cost to the United Nations. In the case of UNISPACE 82, the Secretary-General of the Conference was appointed 22 months prior to the convening of the Conference and took office about 17 months prior to it.

Other activities related to the conference

62. UNISPACE 82 clearly illustrated the value of holding, under the auspices of the United Nations Programme on Space Applications, regional seminars and workshops, devoted to subjects to be considered by the conference. Such activities would serve to focus the attention of Member States on the subjects to be considered by the conference and would help to create a productive environment for the conference by ensuring that potential participants are well informed and well prepared. It would also be valuable to conduct several meetings and/or round-tables featuring international experts in various fields of space technology and policy who would not be otherwise directly involved in the conference. Such activities could prove useful for generating new ideas that could then be taken up by the conference.

63. Most activities of the United Nations Programme on Space Applications should be oriented towards conference preparations beginning approximately 18 months prior to the beginning of the conference. The regional commissions and other relevant United Nations entities should be involved in the planning and organization of regional seminars related to preparations for the conference.

64. The secretariat of the conference would also be responsible for developing and implementing a broad public information programme to create greater awareness of the conference, not only among relevant policy makers and governmental institutions, but also among non-governmental organizations and the general public. The highly successful information programme implemented for UNISPACE 82 could serve as a model. Consideration should be given to including the following elements in such an information programme:

(a) Publishing of a periodic newsletter;

(b) Press, radio and television publicity;

(c) Organization of long-term exhibits as part of existing visitor services at United Nations Headquarters, the United Nations Office at Geneva and the United Nations Office at Vienna;

(d) Dissemination of background information (booklets, audiovisual material etc.) on space technology and the goals of the conference;

(e) Organization of scientific seminars and "poster sessions" on topics related to the conference to be held immediately prior to the conference;

(f) Organization of a "media encounter" immediately prior to the convening of the conference to familiarize representatives of accredited media with the background of the conference as well as its objectives;

(g) Organization at the conference site of a major exhibition on space technology and applications for the duration of the conference;

(h) Organization of a series of evening lectures by specialists in various fields of space science and technology during the conference;

(i) Issuance by the United Nations Postal Administration of a stamp on the theme(s) of the conference;

(j) Organization of an international poster contest and essay competition.

65. Many of the above-mentioned activities should be organized and conducted with the support, both financial and in kind, of Member States, international organizations and relevant non-governmental organizations, including the Committee on Space Research (COSPAR) of the International Council of Scientific Unions, the International Astronautical Federation (IAF), the International Society for Photogrammetry and Remote Sensing (ISPRS) and the International Astronomical Union. Past experience has shown that, if properly mobilized, such organizations could effectively organize those activities and that funds in the conference budget allocated to publicity could be effectively utilized as seed money for those activities. Thus, many of the activities could be conducted within existing budgetary resources.

66. The holding of a forum of non-governmental organizations has become common practice at major United Nations conferences. Such a forum would help raise the profile of the proposed conference and at the same time would allow a wide variety of non-governmental organizations to participate when they would otherwise have no formal role. Such an activity has usually been organized by non-governmental organizations with the support of the host country at no cost to the United Nations.

67. In order to organize the public information programme, the secretariat of the conference would use the existing United Nations resources and expertise, particularly those of the Department of Public Information of the Secretariat. The secretariat of the conference and the Department of Public Information would cooperate closely to ensure an effective information programme and optimum use of resources.

Host country agreement

68. Because of the broad scope of and potentially large participation in a third UNISPACE conference, it would be necessary to ensure close cooperation with governmental and non-governmental authorities in the host country. It would also be necessary to have in place a host country agreement at the earliest possible date, preferably not later than one year prior to the convening of such a conference. Such an agreement would be necessary if the conference were not held at United Nations Headquarters, the United Nations Office at Geneva or the United Nations Office at Vienna. It would also be necessary if the Government of Austria, Switzerland or the United States of America would decide to act as host to the proposed conference. Negotiations on such an agreement should begin immediately following a decision by the General Assembly on the venue of the proposed conference.

Organization of the conference

69. Participation in a third UNISPACE conference should be open to all Member States, as well as to relevant intergovernmental and non-governmental organizations, who would participate as observers.

70. The conference should be held over a two-week period, allowing three days for plenary meetings at the beginning of the conference and two days at the end of the conference for the adoption by the plenary of the report of the conference. The committees could meet for three or four days each, in parallel with the plenary meetings and with each other, depending on the number of committees and the agenda of the conference.

There might be three committees, with a maximum of two meetings taking place at any time, an arrangement that proved effective at UNISPACE 82.

71. Possible general themes to be covered by the committees could include:

(a) Review of developments in space science, technology and applications since the convening of UNISPACE 82, with emphasis on their relevance to and impact on developing countries;

(b) Review of policy issues affecting international cooperation in space activities;

(c) Review of the effectiveness of existing mechanisms for international cooperation in space activities; the strengthening of those mechanisms and the creation of new modalities of international cooperation.

72. Within the context of these general themes, the committees could also discuss more specific areas such as:

(a) The impact, implications and potential benefits of transnational satellite broadcasting, particularly for educational and development purposes;

(b) Contributions that space technology can make in implementing national and international sustainable development programmes;

(c) Strengthening and expanding international cooperation in meteorology, disaster warning and relief, and navigation through the use of space technology;

(d) Improved mechanisms for training and education in space science, technology and applications;

(e) Benefits of spin-offs from space technologies and the application of those spin-offs in economic and social development;

(f) Expansion and improvement of the space-related activities of the United Nations.

73. The themes of the committees could be determined in consultations and negotiations in both the preparatory committee and the advisory committee.

74. In addition, there should be at least one day of informal pre-conference consultations on procedural and organizational matters, as well as a briefing for all delegates to provide them with details on the arrangements for the conference and to discuss any outstanding matters related to the draft final document(s) to be adopted by the conference.

75. Officers of the conference should be agreed upon prior to the convening of the conference in informal discussions within the regional groups and the preparatory committee. As this is often a politically sensitive process, discussions on the matter should begin as soon as possible and should be finalized preferably six months prior to the convening of the conference.

Timing and schedule

76. A proposed schedule for the preparations for a third UNISPACE conference was contained in the working paper submitted by States members of the Group of 77 at the thirty-first session of the Scientific and Technical Subcommittee (A/AC.105/C.1/L.199). The proposed schedule is contained in annex I of the present report. The preparation periods for United Nations conferences tend to be shorter for highly

specialized conferences or for conferences with limited objectives than for conferences with broader mandates. The proposed schedule contained in annex I is feasible but is predicated on the assumption that the necessary agreements will be reached within the Committee in time for the General Assembly to approve the convening of such a conference at its forty-ninth session, in 1994. In determining the actual timing of such a conference, it should be kept in mind that the General Assembly, in its resolution 40/243, section I, of 18 December 1985, requested the Committee on Conferences and the Secretary-General to take account of a number of principles in drawing up the calendar of conferences and meetings, including the principles that no more than one special United Nations conference should be convened at the same time and that no more than five such conferences should be held in any given year. According to the Office of Conference Services of the Secretariat, one major conference is currently scheduled for 1996 (the United Nations Conference on Human Settlements, to be held from 3 to 14 June in Turkey). No major conferences have been approved for 1997.

Possible outcomes of the conference

77. Consideration should be given at the earliest possible stages of conference preparation as to the form and scope of any recommendations or programme of action to be adopted by the conference. In addition to any financial implications (see paragraphs 92-94 below), careful planning is necessary to ensure that any such recommendations are realistic and feasible. It should be noted that one of the criticisms levelled at UNISPACE 82 was that its recommendations were too broad, unfocused and idealistic.

78. In this regard, it would be useful to conduct a thorough critical review of the UNISPACE 82 recommendations and their implementation as part of the preparatory process for a third UNISPACE conference. Such a review would provide the preparatory committees valuable insight into what types of programmes have been successfully utilized as a mechanism for implementing the recommendations of UNISPACE 82, and conversely, would provide insight into why certain recommendations have not yet been implemented.

B. Funding

79. Additional funding for a third UNISPACE conference, primarily for pre-conference activities, committee servicing during the conference, support staff and other related activities, would be required to the extent that funding requirements cannot be met from within existing budgetary resources.

80. Funding for a third UNISPACE conference could come from four sources:

(a) The United Nations system (to cover staff, conference-servicing costs);

(b) The host country (to cover incremental costs, discretionary services and activities);

(c) Other international organizations (support for preparatory activities, provision of expert services not available within the secretariat of the conference, organization and support of scientific and technical seminars, meetings and exhibits);

(d) Voluntary contributions (for regional preparatory conferences, public information activities and general support for all other activities).

United Nations funding

81. It should be noted that all figures cited in the present subsection are preliminary estimates only and are based on the information available as of April 1994. They are provided only for the information of the

Committee on the Peaceful Uses of Outer Space. It should also be noted that the figures would have no impact on existing budget appropriation for the biennium 1994-1995 and that, therefore, there would be no requirement to prepare a statement of programme budget implications for consideration by the Committee at its thirty-seventh session.

82. Estimates for conference-servicing costs are made on a full-cost basis and are based on the assumption that no part of those costs would be met from within the permanent conference-servicing capacity of the programme budget that would be in place during the biennium in which a third UNISPACE conference would be held and that additional resources would be needed for temporary assistance for meetings. The estimates make no assumptions with regard to the absorptive capacity of the conference-servicing resources at each duty station and the extent to which the permanent capacity of the United Nations would need to be supplemented by temporary assistance resources. Those can be determined only taking into consideration the calendar of conferences for the period 1994-1995. The Financial Service of the United Nations Office at Vienna has agreed to release the cost estimates contained in the present report only with the disclaimer that the amount of the cost that could be absorbed by the established conference-servicing capacity has not been included in those costs and that it is clear that in the case of Vienna, as much as 50 per cent of the total estimated cost of $775,224 could be absorbed at the time the conference is tentatively scheduled for.

83. Preliminary cost estimates for a third UNISPACE conference, provided by the Financial Service of the United Nations Office at Vienna (see annex II) are based on the following assumptions:

(a) The Office for Outer Space Affairs would be responsible for the substantive and administrative arrangements for the conference and would provide the executive secretary of the conference; thus, the services of the executive secretary would be funded from within existing resources;

(b) The conference would be held for two weeks in August 1996;

(c) There would be a total of four meetings per day of the plenary and of the three committees of the whole and not more than two meetings would be held simultaneously. There would be interpretation in all six official languages of the United Nations;

(d) There would be no summary records;

(e) Documentation, in the six official languages, would be comprised of 100 pages of pre-session, 50 pages of in-session and 100 pages of post-session documents, in addition to background documentation that, to the maximum extent feasible, would be financed from within existing resources;

(f) If a Government would host the conference and the conference would not be held at Vienna, the travel and daily subsistence allowance costs for approximately 12 substantive officers from the Office for Outer Space Affairs to service the conference would, in accordance with the relevant General Assembly resolutions, be absorbed by the host country;

(g) Salary and common staff costs would be required for the secretary-general of the conference for 12 months, if one is appointed from outside the United Nations;

(h) Temporary assistance would be required for 12 work-months at the P-5 level to augment the substantive secretariat (one officer to serve as a technical writer/editor);

(i) Consultant services would be required for 27 work-months, where the expertise is not available in the secretariat for assisting in the preparation of background papers and provision of technical advice at the regional seminars and at the conference;

(j) Official travel and daily subsistence allowance would be required for the substantive secretariat to attend the regional seminars to assist in the preparation of national papers, to conduct consultations with Governments, the regional commissions and other entities of the United Nations system, and other relevant organizations, and to attend other related international meetings during the preparatory period;

(k) Funding would be required for the preparation and distribution of background and promotional material, the development and implementation of a publicity programme, and assistance for the organization of an exhibit;

(l) Funding would need to be increased for the regional seminars of the United Nations Programme on Space Applications so that they might serve as preparatory seminars for the conference.

84. Conference-servicing costs for four venues (interpretation, translation, documentation, staff for servicing the meetings and other related services), presented in subparagraphs 81 (b)-(e) above, would be as follows (see annex II for a breakdown of these costs):

Bangalore	$641,433
Geneva	$651,586
New York	$641,433
Vienna	$775,224

85. If the conference would be held at a location other than Vienna, there would be additional costs for travel and daily subsistence allowance for 12 substantive secretariat staff from Vienna to the conference site. The costs for four venues, described in subparagraph 81 (f) above, are estimated as follows:

Bangalore	$66,100
Geneva	$56,200
New York	$92,900
Vienna	$0

86. Preliminary estimates for costs described in subparagraphs 81 (g), (h) and (i) above are as follows:

(a) Salary and common staff costs (one post at the Assistant Secretary-General level for 12 months): $177,000;

(b) Temporary assistance (one post at the P-5 level for 12 months): $132,300;

(c) Consultants ($5,000 per month for 27 work-months): $135,000.

These costs would remain fixed regardless of the venue for the conference although the requirements for the item described in subparagraph (b) above might be lower should such services be available from elsewhere within the United Nations Secretariat. Similarly, the actual requirement for the item described in subparagraph (c) above might also be lower if national or regional space agencies would provide such assistance, as was the case with UNISPACE 82.

87. For the purposes of planning, the amounts of $50,000, $50,000 and $75,000, respectively, were used for the items described in subparagraphs 81 (j), (k) and (l) above. The actual requirement for the item described in subparagraph 81 (j) above might be higher or lower depending on whether or not a secretary-general of the conference is appointed and depending on the nature and location of the regional preparatory conferences. The estimate for the item described in subparagraph 81 (l) above assumes that, as was the case prior to UNISPACE 82, voluntary donations to the United Nations Space Applications Programme Trust Fund

would increase during the pre-conference period. If this is not the case, then funding for that element might have to be increased.

Host country funding

88. In accordance with General Assembly resolution 40/243, if the conference would be held at a venue other than Vienna, the host country would be responsible for paying any incremental costs involved in holding the conference away from Vienna. In the case of Bangalore, that would include the travel and daily subsistence allowance costs noted in paragraph 83 above, as well as the travel and daily subsistence allowance costs for conference-servicing staff, who would be sent, based on availability, from United Nations Headquarters, the United Nations Office at Geneva, the United Nations Office at Vienna or a combination of those locations. That cost is estimated to be $419,300. The total estimated net additional cost to be borne by the host Government if the conference would be held at Bangalore is $826,100, as shown in annex III.

89. In addition to reimbursing the United Nations for travel and daily subsistence allowance costs, the host country normally provides facilities and services at no cost to the United Nations, including, conference and exhibition facilities, local transportation, security and support personnel, publicity and other services necessary for the conference.

Voluntary contributions

90. Because of the broad subject-matter to be covered by the proposed conference, it might be possible to solicit support from other international organizations whose missions are closely related to the issues to be considered by the conference. Examples of possible donors include the International Telecommunications Satellite Organization, the International Maritime Satellite Organization, the European Telecommunications Satellite Organization and the European Organization for the Exploitation of Meteorological Satellites, as well as the European Space Agency (ESA) and national space agencies of participating countries. Specialized agencies of the United Nations, such as the Food and Agriculture Organization of the United Nations, the United Nations Educational, Scientific and Cultural Organization, the International Telecommunication Union and the World Meteorological Organization, could also be expected to provide valuable expertise and support.

91. In particular, the support of these and other similar international, non-governmental space-related organizations, such as COSPAR, IAF and ISPRS, which have permanent observer status with the Committee on the Peaceful Uses of Outer Space, would be useful for enhancing the scope and quality of the pre-conference preparatory seminars to be organized under the auspices of the United Nations Programme on Space Applications, for the preparation of background documents and for the organization of related but independent pre-conference seminars, workshops and lectures.

92. Voluntary contributions for particular elements of conference preparation might be solicited from Member States, industry and academic and philanthropic institutions. Such contributions, whether financial or in kind, could be used to support the organization of other related activities to be conducted in conjunction with the conference, such as an exhibition of space technology and spin-offs from space technology and large-scale demonstrations of such technology, as well as academic symposia, and the publication of material to promote the conference objectives.

Comparative cost of recent United Nations conferences

93. The cost of recent major United Nations conferences has varied significantly depending on a variety of factors, including duration, documentation, whether an existing United Nations committee served as the preparatory committee, the number of preparatory meetings, and whether the conference was serviced by an existing secretariat body or if a new secretariat had to be recruited from outside the United Nations. For

example, the budgeted cost of the World Conference on Natural Disaster Reduction, to be held at Yokohama in 1994, based on costs for Geneva, where the secretariat is located, is $1,794,100, not including the incremental costs charged to the Government of Japan (A/C.5/48/58), while the cost of the International Conference on Population and Development, to be held at Cairo in 1994, is budgeted at $5,651,100 (A/C.5/46/25). For comparative figures from UNISPACE 82, see paragraph 49 above.

Other financial issues

94. While not directly related to the financing of the conference, serious consideration must be given at the earliest stages in the substantive development of the conference agenda to the potential financial implications of follow-up activities to be recommended by the conference.

95. Considering that it is unrealistic to expect a significant amount of new funding to be available for new programmes and initiatives that may be recommended by a third UNISPACE conference, creative methods and mechanisms should be considered through which existing financial and organizational resources could be used to implement the recommendations of the conference. Examples include existing funding sources within the United Nations system, such as the United Nations Development Programme (UNDP) and its "Capacity 21" initiative, designed to assist in building national capacities to implement Agenda 21, the United Nations Environment Programme (UNEP), and the Global Environment Facility, which is a joint programme of UNEP, UNDP and the World Bank. Other funding sources, such as regional development banks and existing and planned regional space agencies and organizations, should also be considered in this regard. In order to be most effective, it is important that funding for any programmes and initiatives that may be approved by a third UNISPACE conference should, where appropriate and feasible, be shared among donor and recipient countries.

96. It might therefore be prudent to consider whether one or more meetings at the conference should be devoted to developing solutions to the problem of funding any conference recommendations.

Notes

1/ Official Records of the General Assembly, Forty-eighth Session, Supplement No. 20 (A/48/20), paras. 123-124.

2/ Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992 (A/CONF.151/26/Rev.1 (Vol. I and Vol. I/Corr.1, Vol. II, Vol. III and Vol. III/Corr.1)) (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: Resolutions adopted by the Conference, resolution 1, annex II.

Annex I

SCHEDULE FOR A THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE, AS PROPOSED IN DOCUMENT A/AC.105/C.1/L.199

February-June 1994	Discussion of objectives, agenda, venue and timing of the conference
June 1994	Agreement by the Committee to convene the conference
December 1994	Decision by the General Assembly to convene the conference
January-May 1995	Preparation by the Office for Outer Space Affairs of the basic background documents and an outline of the draft report of the conference
January 1995-June 1996	Implementation of activities of the United Nations Programme on Space Applications devoted to the regional preparations for the conference
February-March 1995	Consideration by the subcommittees of the schedule of preparatory work
June 1995	Consideration by the Committee of the outline of the draft report
June-December 1995	Preparation by the Office for Outer Space Affairs of the first draft of the report
July 1995	Submission of position papers by States and organizations
February-March 1996	Consideration by the subcommittees of the first draft of the report
June 1996	Consideration by the Committee of the second draft of the report
August 1996	Convening of the conference

Annex II

ESTIMATED COSTS TO THE UNITED NATIONS OF A THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE a/

(Costs expressed in US dollars at 1994 rates)

	Bangalore b/	Geneva	New York	Vienna c/
Conference-servicing				
Pre- and post-session documentation, including translation d/	310 554	310 554	310 554	310 554
In-session documentation, including translation	51 999	58 984	51 999	76 638
Staff for servicing meetings	278 880	282 048	278 880	388 032
Substantive secretariat				
Salary and common staff costs e/	177 000	177 000	177 000	177 000
Temporary assistance f/	132 300	132 300	132 300	132 300
Consultants	135 000	135 000	135 000	135 000
Official travel and daily subsistence allowance during preparatory period	50 000	50 000	50 000	50 000
Publicity and background material	50 000	50 000	50 000	50 000
Augmented funding for the United Nations Programme on Space Applications	75 000	75 000	75 000	75 000
Secretariat travel and daily subsistence allowance for the conference	g/	56 200	92 900	-
Office of General Services				
General operating expenses	3 400	3 4000	3 400	3 400
Total	1 264 133	1 330 486	1 357 033	1 397 924

a/ All figures cited are preliminary estimates only and are based on the information available as of April 1994. They are provided only for the information of the Committee on the Peaceful Uses of Outer Space. It should also be noted that the figures would have no impact on existing budget appropriation for the biennium 1994-1995 and that, therefore, there would be no requirement to prepare a statement of programme budget implications for consideration by the Committee at its thirty-seventh session.

b/ Conference-servicing costs for Bangalore, India, are equivalent to those for New York because, under current rules, a conference held at Bangalore would be serviced by conference-servicing staff based in New York. For incremental costs to be borne by the host country, see annex III of the present report.

c/ Estimates for conference-servicing costs are made on a full-cost basis and are based on the assumption that no part of those costs would be met from within the permanent conference-servicing capacity of the programme budget that would be in place during the biennium in which a third UNISPACE conference would be held and that additional resources would be needed for temporary assistance for meetings. The estimates make no assumptions with regard to the absorptive capacity of the conference-servicing resources at each duty station and the extent to which the permanent capacity of the United Nations would need to be supplemented by temporary assistance resources. They can be determined only taking into consideration the calendar of conferences for the period 1994-1995. The Financial Service of the United Nations Office at Vienna has agreed to release the cost estimates contained in the present report only with the disclaimer that the amount of the cost that could be absorbed by the established conference-servicing capacity has not been included in those costs and that it is clear that in the case of Vienna, as much as 50 per cent of the total estimated cost of $775,224 could be absorbed at the time the conference is tentatively scheduled for.

d/ Regardless of the venue of the conference, pre-session and post-session documentation would be processed at Vienna, where the substantive secretariat is based.

e/ Salary and common staff costs of the secretary-general of the conference for 12 months, if one is appointed from outside the United Nations.

f/ Temporary assistance for 12 work-months at the P-5 level to augment the substantive secretariat (one officer to serve as technical writer/editor).

g/ See annex III of the present report.

Annex III

ESTIMATED NET ADDITIONAL COSTS TO BE BORNE BY THE HOST GOVERNMENT OF A THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE IF THE VENUE WOULD BE BANGALORE, INDIA
(Costs expressed in US dollars at 1994 rates)

	Estimated net additional costs to be borne by the host Government
Conference-servicing	
Meeting-servicing staff, travel and daily subsistence allowance (67 interpreters, translators and other conference-servicing staff sent from New York)	419 300
Pre-conference consultations (2 days, 14 interpreters)	3 600
Two planning missions (1 week each, 6 staff)	67 300
Substantive secretariat	
Travel and daily subsistence allowance for the conference	66 100
Other requirements	
Pouch, freight, telephone, telex etc.	158 900
Administrative support (5 per cent)	35 800
Contingency (10 per cent)	75 100
Total	826 100